# A TUTOR to
# Aſtronomy and Geography.

Or, an eaſie and ſpeedy way to know the USE of both the

# GLOBES,

## *Cœleſtial* and *Terreſtial.*

In Six Books.

The
1. Teaching the Rudiments of *Aſtronomy* and *Geography*,
2. Shewing *Aſtronomical* and *Geographical* Problems,
3. by the Problems in *Navigation*,
4. GLOBES *Aſtrological* Problems,
5. the Solu- *Gnomonical* Problems,
6. tion of *Trigonometrical* Problems,

More fully and amply than hath been ſet forth, either by *Gemma Friſius*, *Metius*, *Hues*, *Wright*, *Blaew*, or any others that have Taught the Uſe of the GLOBES: And that ſo Plainly and Methodically, that the meaneſt Capacity may at firſt Reading apprehend it, and with a little Practice grow expert in theſe Divine Sciences.

With an Appendix ſhewing the Uſe of the *Ptolomaick Sphere.*

*The Fifth EDITION, Corrected and Enlarged.*

By **Joſeph Moxon.**

Whereunto is added the Antient *Poetical Stories of the Stars*; ſhewing Reaſons why the ſeveral Shapes and Forms are pictured on the *Cœleſtical Globe*. As alſo a Diſcourſe of the *Antiquity*, *Progreſs* and *Augmentation* of *Aſtronomy*

Job XXVI. 7. 13.

*He ſtretcheth out the North over the empty Place, and hangeth the Earth upon nothing. By his Spirit he hath garniſhed the Heavens, His hand hath framed the crooked Serpent.*

*LONDON*,
Printed for *W. Hawes* at the *Roſe* in *Ludgate-ſtreet*, 1699.

Joseph Moxon.
Born at Wakefeild *August* 8.
*Anno* 1627.

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Job XXVI. 7. 19.

*He stretched [illegible] North over the empty Place, and hangeth the Earth upon nothing. He bath [illegible] Heaven and hath framed the crooked Serpent.*

LONDON,

Printed for W. Hawes at the Rose in Ludgate-street, 1699.

To His Excellency

# THOMAS,

*Earl of* Pembrook *and* Montgomery, *Baron* Herbert *of* Cardiff, *Lord* Roſs *of* Kendall, Par, Marmion, St. Quintin *and* Shurland: *One of the Lords Juſtices of* England, *Lord* Privy Seal: *Lord Lieutenant of the County of* Wilts, *and of* South Wales: *And One of His Majeſty's Moſt Honourable* Privy Council.

May it pleaſe Your EXCELLENCY.

*ALthough Your Exaltation (ſo worthy Your Merit) is to the higheſt Dignity, and Greateſt Truſt, that a moſt Gracious Sovereign could Confer upon your Excellency; yet Your Motion is not in ſo high a Sphear, but that the Benignity of Your Influence is extenſive to the minuteſt Performances, and whatever can come under the Denomination of Solid and Uſeful Learning, and that to ſuch a Degree, that I muſt be taxed much more with Modeſty in forbea-*

*ring, than I can possibly be with either Vanity, or Flattery, in Saluting your Excellency with the Title of the* Mæcenas of our Age. *Wherefore in a firm Assurance hereof, and as a Testimony of my humble Respects to your Excellency, I cannot pretermit this Opportunity of presenting You with the* Fifth Impression *of the Use of the* Coelestial *and* Terrestrial Globes, *in the best Perfection it has hitherto appear'd in the World, and humbly Craving Your Patronage both of it, and him, who is*

Your EXCELLENCY's

Most Humble and

Obedient Servant

*J. Moxon.*

# To the Reader.

## Courteous Reader.

THE Globes *is the first Study a Learner ought to undertake, for without a competent apprehension of them he will not be able to understand any Author, either in* Astronomy, Astrology, Navigation, *or* Trigonometry: *Therefore my aim in this Book hath been to make the Use of them very plain, and easie to the meanest Capacities: In prosecution of which Design, I doubt not the Learneder sort may be apt to Censure me guilty of Prolixity, if not Tautology: Because the precepts being plain, they may account some of the Examples Useless: But I desire them to consider, that I write not to expert Practitioners, but to Learners; to whom Examples may prove more Instructive than Precepts. Besides, I hope to encourage those by an ample liberal plainness, to fall in Love with the Studies, that formerly have been disheartned by the Crabbed brevity of those Authors that have (in Characters as it were rather writ Notes for their own Memories, than sufficient Documents for their Reader's Instructions.*

*The Globes for which this Book is written are new Globes that I set forth, which, as I told you in my Epistle to the Reader of* Blaws *Book, differs somewhat from other Globes, and that both the* Coelestial *and the* Terrestrial, *mine being the latest done of any, and to the accomplishing of which I have not only had the help of all, or most of the best of other Globes, Maps, Platts, and Sea-drafts of New discoveries that were then extant for the* Terrestrial Globe, *but also the Advice and directions of divers able Mathematicians, both in* England *and* Holland, *for Tables and Calculations both of the Lines and Stars for the* Coelestial; *upon which Globe I have placed every Star that was observed by* Tycho Brahe *and other Observers, one degree of Longitude farther in the Ecliptick than they are on any other Globes; so that whereas on other Globes the places of the Stars were correspondent with their places in Heaven* 69 *Years ago, when* Tycho *observed them, and therefore according to his Rule want almost a degree of their true places in Heaven at this Time; I have set every Star one degree farther in the Ecliptick, and rectified them on the Globe, according to the true place they had in Heaven in the Year* 1671.

*On the* Terrestrial Globe *I have inserted all the New discoveries that have been made, either by our own, or Forraign Navigators, and that both in the East, West, North and South parts of the Earth. In the* East-Indies *we have in these latter Times many spacious places discovered, many Islands inserted, and generally the whole Draught of the Country rectified and amended, even to the Coast of* China, Japan, Giloli, *&c. In the* South Sea *between the* East *and* West-Indies *are scattered many Islands, which for the uncertain knowledge former Times had of them, are either wholly left out of other Globes, or else laid down so erroneously, that little of credit can be attributed unto them.* California *is found to be an Island, though formerly supposed to be part of the main Continent, whose North-West shoar was imagined to thrust it self forth close to the Coasts of* Cathaio, *and so make the supposed* Straights *of* Anian. *The Western Shoars of the* West-Indies *are more accurately described than formerly, as you may, see if you compare my* Terrestial Globe, *that I have lately set forth with the Journals of the latest Navigaters: And if you compare them*

*with*

with other Globes you will find 5, 6, yea 7 degrees difference in Longitude in most Places of these Coasts. Magellanica which heretofore was thought to be part of the South Continent called Terra Incognita is now also found to be an Island. All that Tract of Land called Terra Incognita I have purposely omitted, because as yet we have no certainty whether it be Sea or Land, unless it be of some parts lately found out by the Dutch; who having a convenient Port at Batavia in Java, have from thence set forth Ships Southwards, where they have found several very large countries: one whereof they have called Hollandia Nova, another Zelaneir Nova, another Antonii van Diemans Land; and divers others, some whereof lie near our Antipodes, as you may see by my Terrestrial Globe. Again, Far to the Northwards there are some New Discoveries, even within six degrees of the Pole: The Drafts to the North Eastwards I have laid down even as they were described by the Searchers of those parts for a passage into the East-Indies. And also the Discoveries of Baffin, Capt. James, and Capt. Fox (our own Country-men) that attempted the finding a passage that way into the South Sea.

I also told you what difference there is in several Authors about placing the first Meridian, which is the beginning of Longitude; that Ptolomy placed it at the Fortunate Islands, which Mr. Hues pag. 4. Chap. 1. in his Treatise of Globes proves to be the Islands of Cabo Verde, and not those now called the Canary Islands; because in his Time they where the furthest place of the Discovered World towards the setting of the Sun: Others placed it at Pico in Teneriffa; Others at Corvus and Flora; because under that Meridian the Compass had no Variation, but did then duly respect the North and South; Others for the same Reason began their Longitude at St. Michaels; and others between the Islands of Flores and Fayal: And the Spaniards of late by reason of their great Negotiation in the West-Indies, have begun their Longitude at Toledo there, and contrary to all others account it Westwards.

Therefore I seeing such diversity among all Nations, and as yet an Uniformity at home, chose with our own Country-men to place my First Meridian at the Isle Gratiosa, one of the Isles of Azores.

By the different placing of this first Meridian it comes to pass, that the Longitudes of places are diversly set down in different Tables; For those Globes or Maps that have their first Meridian placed to the Eastwards of Gratiosa, have all places counted Eastwards between the first Meridian and the Meridian of Gratiosa in fewer degrees of Longitude: And those Globes and Maps that have their first Meridian placed to the Westward, have all places counted Eastwards from the Meridian of Gratiosa, and their first Meridian in a greater number of degrees of Longitude, and that according as the Arch of Difference is.

As an Appendix to this Book, I have added a description of the Ptolomaick Spheres, and have inserted some particular Problems of its use; together with Instructions how the whole use of that Sphere, may easily be known by this Book.

I have also annexed a small Collection out of Dr. Hood, which declares the Reasons why such strange Figures and Forms are pictured on the Cœlestial Globe; and withal, the Poetical Stories of every Constellation.

I likewise thought good to add at the latter end of this Book, a small Treatise, intituled The Aniqtuity, Progress, and Augmentation of Astronomy. I may without partiality give it the Encomium of a Pithy, Pleasant, and Methodical piece: It was written by Gassendus, and is worthy the Perusal of all Ingenious Lovers of the Studies.

Joseph Moxon.

# The First BOOK:

Being the first *Rudiments* of

# Astronomy *and* Geography.

OR, A

Description of the *Lines*, *Circles*, and other Parts of the

# GLOBES.

## PREFACE.

THE *Students of all Arts and Sciences have ever proposed a Maxim, whereon (as on an allowed Truth) the whole Science hath dependance: And by so much the more demonstrable that Maxim is, so much the more of Excellency the Science may claim.*

*This of* Astronomy *and* Geography *comes not behind any; for herein we shall only admit (with the Ancients) that the Form of the visible* World *is* Spherial: *Neither shall we beg our Assertion any further than* Ocular Appearance *will demonstrate: Every Mans Eye being his Judge, if he be either on a* Plain Field, *or at* Sea, *where nothing can hinder a free inspection of the* Horizon.

*Upon good grounds therefore, they asserted the Spherical form of the Whole: And also concluded the Parts to be Round: I mean every intire Subsistence, as the* Stars, Planets, *and the* Earth. *In the* Celestial Bodies (*as the* Stars *and* Planets) *this is also visible; and therefore uncontroulable: But that the* Earth *is Round proves with*

*the unskilful, matter of dispute; they frequently objecting with S.* Austine *the words of the Scripture, which say,* He hath stretched forth the Corners of the Earth; *not considering whether those Words were spoken as alluding to the amplitude of Gods Omnipotence, or that the* Corners *were meant* Capes *of* Land, *which indeed are stretched forth into the Sea. But that the* Earth *is Round is proved by divers certain and infallible Reasons.*

*As first, By the* Navigations *of our Age, Divers able and honest Mariners Sailing and continuing an* Easterly Course, *have at length arrived (without turning back) to the same Place from whence they set forth: Witness* Magellanicus, *Sir* Francis Drake, Tho. Cavendish, Oliver vander Noort, W. Schouten, *&c.*

*Secondly, By the length of Degrees in every Parallel; for it is found by Duly observation that the Degrees of every Parallel upon the* Earth, *hold the same proportion to the Degrees of the* Equinoctial, *as the Degrees of the same Parallel upon an Artificical* Globe *or* Sphere *do to the Degrees of the greatest Circle of the same: This Argument alone is sufficient: Yet take one more from visible Appearance; and that is this; the shadow which the* Earth *and* Water *together make in the* Eclipse *of the* Moon *is always a part of a Circle; therefore the* Earth *and* Water, *which is the Body shadowing, must also be a Circular or Round Body; for if it were three square, four square, or any other form, then would the shadow which it makes in the Moon be of the same fashion.*

*Besides, Of all figures the* Sphere *or* Globe *is most Perfect, most Capacious, and most Intire of it self, without either Joynts or Angles; which form we way also perceive the* Sun, Moon, *and* Stars *to have, and all other things that are bounded by themselves, as Drops of* Water, *and other liquid things.*

*But*

*But there is another frequent Argument againſt the* Globulous *form of the* Earth; *and that is, That it ſeems impoſſible that the* Earth *ſhould be Round, and yet alſo Inhabitable in all Places: For though We that Inhabit on the top of the* Earth *go with our Heads upwards; yet thoſe that Inhabit underneath us, muſt needs go with their Heads downwards, like Flyes on a Wall or Cieling; and ſo be in danger of falling into the* Air.

*For Anſwer hereunto, Firſt; You muſt underſtand that in the Center of the* Earth *there is an Attractive and Drawing Power, which draws all heavy ſubſtances to it: By virtue of which Attractive Power, things tho looſed from the* Earth *will again incline and cling to the* Earth, *and ſo much the more forcibly, by how much the heavier they are; as a Bullet of* Lead *let fall out of the* Air, *inclines towards the* Earth *far more violently and ſwiftly than a Bullet of the ſame bigneſs of Wood or Cork.*

*Secondly, You muſt underſtand that in reſpect of the whole Univerſe there is no part either Upper or Under; but all parts of the* Earth *are alike incompaſt with* Heaven; *yet in reſpect of the* Earth, *it is* Heaven, *which we take for the Upper part: And therefore we are ſaid to go with our Heads upwards; becauſe our Head (of all the parts of our Body) is neareſt to* Heaven.

*Now that this Attractive Power lies in the Center of the* Earth *is proved by this Argument: If the Attractive Power were not in the Center, a Plumb-line let fall would not make Right Angles with the Superficies of the Earth; but would be Attracted that way the Attractive virtues lies, and ſo make unequal Angles with the Superficies: But by ſo many Experiments as have yet been made, we find that a Plumb-line continued, though never ſo Deep, yet it alters no Angles with the Superficies of the* Earth; *and therefore undoubtedly the Attractive Power lies in the very Center, and no where elſe.*

# CHAP. I.

## § I. *What a* Globe *is.*

A *Globe* (according to the Mathematical Definition) is a perfect and exact round Body, contained under one Surface.

Of this Form (as hath been proved) consists the *Heavens* and the *Earth*: And therefore the Ancients with much Pains, Study and Industry, endeavouring to imitate as well the imaginary as the real appearances of them both, have Invented two *Globes*, the one to represent the *Heavens*, with all the *Constellations*, *fixed Stars*, *Circles* and *Lines* proper thereunto, which *Globe* is called the *Cœlestial Globe*; and the other with all the *Sea Coast*, *Havens*, *Rivers*, *Lakes*, *Cities*, *Towns*, *Hills*, *Capes*, *Seas*, *Sands*, &c. as also the *Rumbs*, *Meridians*, *Parallels*, and other *Lines* that serve to facilitate the Demonstration of all manner of Questions to be performed upon the same: And this *Globe* is called the *Terrestrial Globe*.

## § II. *Of the two* Poles.

Every *Globe* hath two *Poles*, the one *North*, and the other *South*. The *North Pole* is the *North* point of the *Globe*: The *South Pole* is the *South* point.

## § III. *Of the* Axis.

From the Center of the *Globe* both ways proceeds a Line through both the *Poles*, and continues itself infinitely; which is called the *Axis of the World*; and is represented by the two wyers in the *Ploes* of the *Globe*: Upon these two wyers the *Globe* is turned round, even as the *Heavens* is imagined to move upon the *Axis* of the *World*.

## § IV. *Of the* Brasen Meridian.

Every *Globe* is Hung by the *Axis* at both the *Poles* in a *Brasen Meridian*, which is divided into 360 *degrees*; (or which is all one into 4 Nineties: The first beginning at the *North Pole*, is continued from the left hand towards the right, till the termination of 90 *degrees*, and is marked with 10, 20, 30, 40, &c. to 90. from whence the *degrees* are numbred with 80, 70, 60, &c. to 0. which is in the *South Pole*: From whence again the *degrees* are numbred with 80, 70, 60, &c. to 0. and lastly from 0 the

*degrees*

*degrees* are numbred with 10, 20, 30, to 90. which is again in the *North Pole.*

This *Brasen Meridian* is of great use; for by the help of it you may find the *Latitude* of all Places, the *Right Ascention* and *Declination* of all the *Stars*, &c. and Rectifie the *Globe* to any Latitude.

## § V. *Of the* Horizon.

The *Horizon* is a broad Wooden Circle, encompassing the *Globe*; having two Notches in it, the one in the *North*, the other in the *South* point: The Notches are made just fit to contain the *Brasen Meridian* that the *Globe* is Hung in: In the Bottom or under Plain of the *Horizon* there stands up a Prop, or (as it is called) a *Bed*, in which there is also a Notch, into which Notch the *Brasen Meridian* is also let, so low as that both it and the *Globe* may be divided into two equal halfs by the upper Plain of the Wooden *Horizon*. These Notches are as gages to keep the *Globe* from inclining more to the one side of the Wooden *Horizon* than the other.

Upon the upper Plain of the *Horizon*, is several *Circles* delineated: As first, the Inner *Circle*, which is a *Circle* divided into twelve equal parts, *viz.* into twelve *Signs*, every *Sign* having its name perfixed to it; as to the *Sign* of ♈ is the word *Aries*; to ♉ the word *Taurus*, &c. every *Sign* again is divided into 30 equal parts which are called *Degrees*, and every tenth *Degree* is marked with 10, 20, or 30.

Next to the *Circle of Signs* is a *Kalender* or *Almanack*, according to the *Old Stile* used by us here in *England*, each *Month* being noted with its proper name; as *January*, *February*, *March*, *&c.* and every *Day* distinguished with Arithmetical Figures, at 1, 2, 3, 4, &c. to the end of the *Month*.

The other *Kalender* is a *Kalender* of the *New Stile*; which is in manner all one with the *Old*; only in this *Kalender* the *Month* begins ten days sooner than they do in the other: And to this *Kalender* (because it was instituted by the Church of *Rome*) there is annexed the *Festival Days* celebrated by the *Romish* Church.

The two other *Circles* are the *Circles* of the *Winds*; the innermost having their *Greek* and *Latine* Names, which by them were but twelve; and the outermost having the *English* Names, which for more preciseness are two and thirty.

The

The use of the upper plain of the *Horizon* is to distinguish the *Day* from *Night*; the *Rising* and *Setting* of the *Sun*, *Moon*, or *Stars*, &c. and for the finding the *Azimuth*, and *Amplitude*, &c.

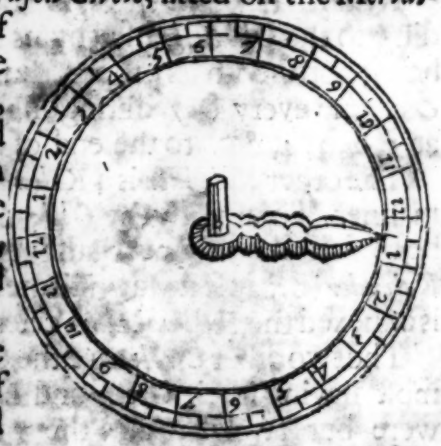
## § VI. *Of the* Quadrant *of* Altitude.

The *Quadrant of Altitude* is a thin Brass Plate, divided into 90 Degrees, and marked upwards with 10, 20, 30, 40, *&c.* to 90. It is revitted to a Brass Nut, which is fitted to the *Meridian*, and hath a Screw in it, to screw upon any Degree of the *Meridian*. When it is used it is most commonly Screwed to the *Zenith*. Its use is

for measuring the *Altitudes*, finding *Amplitudes*, and *Azimuths*, and describing *Almicantaraths*. It would sometimes stand you in good stead if the Plate were longer by the breadth of the *Horizon* than 90 Degrees; for then that length being turned back will serve you instead of an *Index*: When the *Nut* is screwed to the *Zenith*, to cut either the Degrees or Days of either *Stile* or the *Points of the Compass* in any of those *Circles* concentrical to the innermost edge of the *Horizon*: which the Eye cannot so well judge at.

## § VII. *Of the* Hour Circle, *and its* Index.

The *Hour Circle* is a small *Brasen Circle*, fitted on the *Meridian*, whose Center is the *Pole* of the World: It is divided into the 24 Hours of the Day and Night, and each Hour is again divided into Halfs and Quarters, which in a Revolution of the *Globe* are all pointed at with an *Index*, which to that purpose is fitted on the *Axis* of the *Globe*.



The use of the Hour Circle is for the shewing the Time of the several Mutations and Configurations of *Celestial* Appearances.

§ VIII.

## § VIII. *Of the* Nautical Compaſs, *or* Box *and* Needle.

Juſt under the *North* point of the *Horizon*, upon the undermoſt Plain is ſometimes fixed a *Nautical Compaſs*, whoſe *North* and *South* line muſt be Parallel to the *North* and *South* line of the *Horizon*. The Uſe of it is for ſetting the Angles of the *Globe* correſpondent to the Angles of the *World*.

## § IX. *Of the* Semi-Circle *of* Poſition.

Thoſe that are *Aſtrologically* addicted, will want a Circle of Poſition to their Globes.

This is a *Semi-Circle* made of Braſs and divided into 180 degrees, numbred from the Equinoctial on either ſide with 10, 20, 30, &c. to 90. At the two ends there is an *Axis*, which is fitted into the two Holes of two ſmall Studs, fixed in the *North* and *South* line of the upper Plain of the *Horizon*: Upon this *Axis* it is moved up and down, according to the intent of your Operation.

The Uſe of this *Circle of Poſition* is, for the finding the *twelve Aſtrological Houſes of Heaven*; and alſo for finding the *Circle of Poſition* of any *Star* or Point in *Heaven*.

Thus much may ſerve for the lineaments circumjacent to the body of the Globe. The next diſcourſe ſhall be

# CHAP. II.

## *Of the* Circles, Lines, *&c. deſcribed upon the* Superficies *of the* Globe; *beginning with the* Terreſtrial Globe; *and*

## § I. *Of the* Equator.

THe *Equator* is a great *Circle*, encompaſſing the very middle of the *Globe* between the two *Poles* thereof, and divides it into two equal parts, the one the *North* part, and the other the *South* part. It is (as all Great Circles are) divided into 360 equal parts, which are called *Degrees*. Upon this *Circle* the *Longitude* is number'd, from *Weſt* to *Eaſt*, and from this *Circle* both ways, *viz. North* and *South* the *Latitude* is reckoned. It is called the *Equator*, becauſe when the *Sun* comes to the Line (which is twice in one Year, to wit, on the Tenth of *March*, and

and the Thirteenth of *September*) the *Days* and *Nights* are Equated, and both of one Length.

## § II. *Of the* Meridians.

There are infinite of *Meridians*, for all Places lying *Eaſt* or *Weſt* from one another have ſeveral *Meridians*; but the *Meridians* delineated upon the *Terreſtial Globe* are in number 36, ſo that between two *Meridians* is contained ten *Degrees* of the *Equator*. From the *Firſt* of theſe Meridians (which is divided into twice 90 Degrees) accounted from the *Equator* towards either *Pole*, is the beginning of *Longitude*, which upon our *Engliſh Globes* is at the Iſle *Gratioſa*, one of the Iſles of the *Azores*, and numbred in the *Equator Eaſtwards*, with 10, 20, 30. &c. to 360. round about the *Globe*, till it end where it began.

They are called *Meridians*, becauſe they divide the *Day* into two equal parts: For when the *Sun* comes to the *Meridian* of any Place, it is then *Mid-day*, or *Full-Noon*.

## § III. *Of the* Parallels.

As the *Meridians* are infinite, ſo are the *Parallels*; and as the *Meridian* lines delineated upon the *Globe* are drawn through no more than every Tenth *Degree* of the *Equator*, ſo are the *Parallels* alſo delineated but upon every tenth *Degree* of the *Meridian*; leſt the *Globe* ſhould be too much filled with Superfluity of *Lines*, which might obſcure the ſmall Names of Places. The *Parallel Circles* run *Eaſt* and *Weſt* round about the Globe, even as the *Equator*, only the *Equator* is a Great Circle, and theſe are every one leſs than other; diminiſhing gradually till they end in the *Pole*. The *Parallels* are numbred upon the *Meridian* with 10, 20, 30, &c. to 90. beginning in the *Equator*, and ending in the *Pole*.

They are called *Parellels*; becauſe they are *Parallel* to the *Equator*.

## § IV. *Of the* Ecliptick, Tropicks, *and* Polar Circles.

Theſe Circles though they are delineated upon the *Terreſtrial Globe*, yet they are moſt proper to the *Celeſtial*; and therefore when I come to the *Celeſtial Globe*, I ſhall define them unto you.

## § V. *Of the* Rhumbs.

The *Rhumbs* are neither Circles nor ſtreight Lines, but *Heli-ſpherical* or *Spiral lines*: they proceed from the Point where we ſtand, and wind about the *Globe* till they come to the *Pole*; where at laſt they loſe themſelves. They repreſent the 32 *Winds* of the *Compaſs*.

Their Uſe is to ſhew the *Bearing* of any two places one from another: That is to ſay, upon what *Point of the Compaſs* any *Shoar or Land* lies from another.

There are many of them deſcribed upon the *Globe*, for the better directing the Eye from one *Shoar* to the other, when you ſeek after the *Bearing* of any two *Lands*. Some of them (where there is room for it) having the figure of the *Nautical Card* drawn about the Center or common interſection, and have (as all other *Cards* have) for the diſtinction of the *North Point*, a *Flower deluce* pictured thereon.

They were firſt called *Rhumbs* by the *Portugals*; and the name ſince Uſed by *Latine* Authors, and continued by all Writers that have occaſion to ſpeak of them.

## § VI. *Of the* Lands, Seas, Iſlands, *&c. Deſcribed upon the* Terreſtrial Globe.

The *Land* deſcribed upon the *Globe* is bounded with an irregular Line, which runs turning and winding into *Creeks* and *Angles*, even as the *Shoar* which it repreſents (doth.) For the better diſtinction of *Lands &c.* this line is colour'd cloſe by one ſide thereof with divers Colours, as with Red, Yellow, Green, *&c.* theſe Colours diſtinguiſh one part of the *Continent* from the other; and alſo one *Iſland* from another. That ſide of the line which incompaſſes the Colours, is the bounds of the *Land*; the other ſide of the line which is left bare without Colours, is the limits of the *Water*.

The *Land* is either *Continents*, or *Iſlands*.

A *Continent* is a great quantity of *Land*, not interlaced or ſeparated by the *Sea*, in which many *Kingdoms* and *Principalities* are contained; as *Europe*, *Aſia*, *Africa*, *America*.

An *Iſland* is a part of the *Earth*, environed round with *Waters*, as *Britain*, *Java S. Laurence Iſle*, *Bermudas*, &c.

Theſe again are ſubdivided into *Preninſula*, *Iſthmus*, *Promontorium*.

A *Peninsula* is almost an *Island*; that is, a Track of *Land*, which being almost encompassed round with *Water*, is joyned to the firm *Land*, by some little *Istmus*, ; as *Malacca* in the *East-Indies*, &c.

An *Istmus* is a little narrow Neck of *Land*, which joyneth any *Peninsula* to the *Continent*; as the *Straits* of *Dariene* in *Peru*, and *Corinth* in *Greece*.

A *Promontory* is some High *Mountain*, which shooteth it self into the *Sea*, the utmost End or Point of which is called a *Cape*; as that great *Cape of good Hope*, and *Cape Verde* in *Africa*.

The *Water* is either *Ocean*, *Sea*, *Straits*, *Creeks*, *Lakes*, or *Rivers*.

The *Ocean* is that general collection of all *Waters*, which invironeth the whole *Earth* on every side.

The *Sea* is part of the *Ocean*; to which we cannot come but through some *Strait*, as *Mare Mediterraneum*, *Mare Balticum*, and the like.

These take their names either from the adjacent Places, as the *Brittish Ocean*, the *Atlantick Sea*, &c. or from the first Discoverer; as *Mare Magellanicum*; *Davis* and *Forbishers Straits*, &c. Or from some remarkable accident, as *Mare Rubrum*, from the Red colour of the *Sand*; *Mare Ægeum*, *Pontus Euxinus*, and the like.

A *Strait* is a part of the *Ocean* restrained within narrow bounds, and opening a way to the *Sea*; as the *Straits* of *Gibraltar*, *Hellespont*, &c.

A *Creek*, is a crooked *Shoar*, thrusting out (as it were) two arms to imbrace the *Sea*, as *Sinus Adriaticus*, *Sinus Persicus*, &c.

A *River* is a small Branch of the *Sea*, flowing into the *Land*; as *Thames*, *Tiber*, *Rhine*, *Nilus*, &c.

Now that these *Lands*, *Islands*, *Towns*, *Seas*, *Rivers*, &c. may at the first search be found upon the *Globe*, all *Geographers* have placed them thereon according to *Longitude* and *Latitude*.

## § VIII. Longitude.

The *Longitude* is an Arch of the *Equator*, comprehended between the *First Meridian* and the *Meridian* of the *Place* you inquire after. It is numbered on the *Equator* from the *West* to the *Eastwards* with 10, 20, 30, to 360 *Degrees*, till it end where it began.

§ VIII.

## § VIII. Latitude.

The *Latitude* is an Arch of the *Meridian* comprehended between the *Equator* and the *Place* enquired after. It is numbred on the *Meridian* from the *Equator* both ways, *viz. North* and *South*, till it come to the *Poles*, or 90 Degrees.

Thus much may serve for the description of the *Terrestrial Globe*: I therefore come to treat of the *Cœlestial*.

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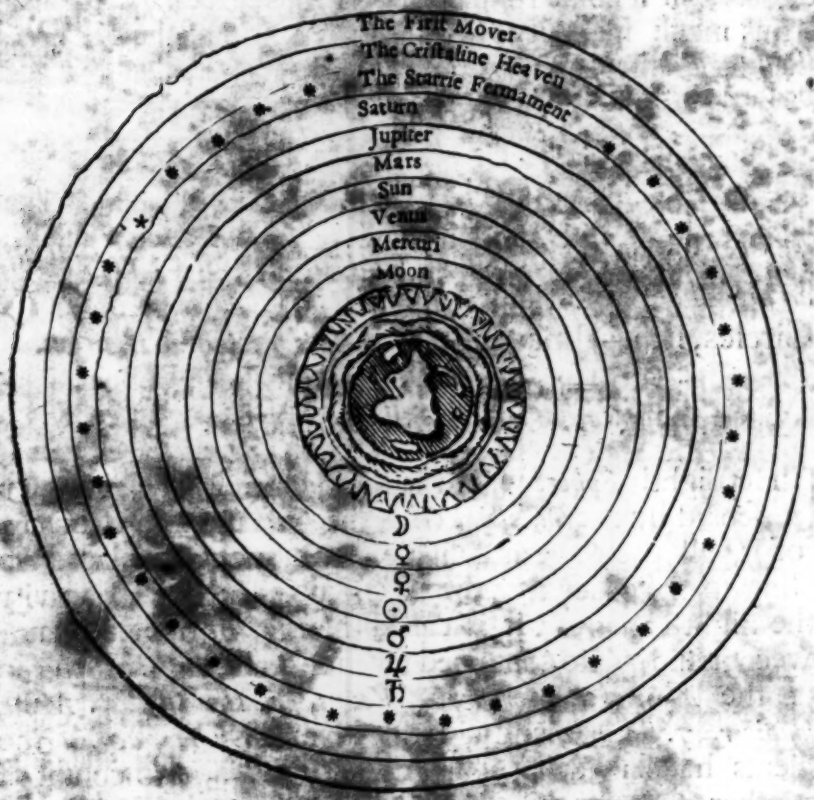
# CHAP. III.

## *Of the* Cœlestial Globe, *or the Eighth* Sphere, *represented by the* Cœlestial Globe: *Its Motion, and of the* Circles, Lines, Images, Stars, *&c. described thereon.*

### § 1. *Of the eighth* Sphere.

THe Eighth *Sphere* which is the *Starry Heaven*, is represented by the *Cœlestial Globe*, because upon the Convexity of it, all the *Stars* and visible appearances, are placed according to the order that they are situated in the Concavity of the Eighth *Sphere*. It is called the *Eighth Sphere*, Because between it and us are contained seven other *Heavens* or *Spheres*; as 1. the *Moon*; 2. *Mercury*, 3. *Venus*, 4. *the Sun*, 5. *Mars*, 6. *Jupiter*, 7. *Saturn*, and eighthly the *Starry Heaven*. The Ancients have made the Systeme of the *World* to consist of two other *Spheres*, called the *Chrystalline Heaven*, and the *Primum Mobili*: Or *first Mover*: As in the following Picture is presented.

*A Figure wherein may be ſeen the Compoſition of the whole Frame of the* World.




## § II. *Of the Motion of the* Eighth Sphear.

There hath been attributed to the *Eighth Sphear* a twofold Motion; the one called its *Diurnal Motion*, which is made from *Eaſt* to *Weſt*, upon the *Poles* and *Axis*, of the *World*, and the other called its *Second Motion*; which is made from *Weſt* to *Eaſt* upon the *Poles* and *Axis* of the *Ecliptick*.

The *Diurnal Motion* is cauſed by the violent Motion of the *Primum*

*Primum Mobile*; for in 24 *Hours* it carries along with it, not only the *Eighth Heaven* or Orb of *Fixed Stars*, but the Orbs of the *Sun*, the *Moon*, and all the rest of the *Planets*. It is called the *Diurnal Motion*, because it is finished in one Day.

The *Second Motion* is unproperly attributed to the *Eighth Sphear*; it being indeed the Motion of the *Equinoctial*, though Authors sometimes carelesly mention the one instead of the other. Therefore in the next *Section*, where I treat of the *Equinoctial*, I shall at large explain unto you the nature of this miscalled *Second Motion*.

## § III. *Of the* Equinoctial.

The *Equinoctial* on the *Cœlestial Globe* is the same line formerly called the *Equator* upon the *Terrestrial*; only with this difference, that the *Equator* remains fixt upon the *Terrestrial Globe*, but the *Equinoctial* upon the *Cœlestial Globe* is moveable; (or at least must be imagined to move) contrary to the *Diurnal Motion* from *West* to *East*, upon the *Poles* of the *Ecliptick*: I say imagined to move, because in the *Heavens* it, with its whole *Orb*, *viz.* the *Eighth Sphear*, doth really move, though on a material *Globe* it would be inconvenient to make a moveable *Equinoctial*, and therefore it hath one fixed: Which for this and the next Age will sufficiently serve, without much deviation from the Truth it self.

Now that the difference between the *Equator* upon the *Terrestrial Globe*, and the *Equinoctial* upon the *Cœlestial*, may be proved; and the Motiyn of the *Equinoctial* be the better understood; I shall only bring this Example;

All places that were formerly under the *Equator*, do and will keep the same *Longitude*, and remain still under the *Equator*: As may be proved by comparing the Ancient and Modern *Geographers* together: But those *Stars* that were formerly under the *Equinoctial*, do not keep the same *Longitude*, nor remain under the *Equinoctial*: because the *Equinoctial* (as aforesaid) hath a Motion from *West* to *East*, upon the *Poles* of the *Ecliptick*. But the *Stars* being fixed in their own *Sphear*, like knots in Wood, therefore move not, are by the Precession of the *Equinox* left behind the *Equinoctial Colure*, and so are caused to alter their *Longitude*; as by comparing the Observations of ancient and Modern *Astronomers* together, it will appear; for about 346

*Years*

*Years* before Christ, the first *Star* in the *Rams horn* was by the *Egyptian* and *Grecian Astronomers* Observed to be in the *Equinoctial Colure*: And 59 *Years* ago, when *Tycho* Observed, it was found to be in 27 *Degrees*, 37 *Minutes* of ♈. So that in about 2000 *Years* it is moved forwards 28 *Degrees*, and will according to *Tycho*'s opinion, finish its Revolution in 25412 *Years*: According to which Motion, I have Calculated this following Table, for finding the *Degrees* and *Minutes* of the *Equinoctial* Motion, answerable to any number of *Years* within the said Revolution.

| ye. | deg. | m. | years. | deg. | m. |
|---|---|---|---|---|---|
| 1 | 0 | 0¼ | 100 | 1 | 25 |
| 2 | 0 | 1½ | 200 | 2 | 50 |
| 3 | 0 | 2½ | 300 | 4 | 15 |
| 4 | 0 | 3⅓ | 400 | 5 | 40 |
| 5 | 0 | 4¼ | 500 | 7 | 5 |
| 6 | 0 | 5 | 1000 | 14 | 10 |
| 7 | 0 | 5¾ | 2000 | 28 | 20 |
| 8 | 0 | 6½ | 3000 | 42 | 30 |
| 9 | 0 | 7¼ | 4000 | 56 | 40 |
| 10 | 0 | 8½ | 5000 | 70 | 50 |
| 20 | 0 | 17 | 10000 | 141 | 40 |
| 40 | 0 | 34 | 20000 | 283 | 20 |
| 60 | 0 | 51 | 25000 | 354 | 10 |
| 80 | 1 | 8 | 25412 | 360 | |

This Table may be of Use for finding the *Equinoctial* position of any *Star*, for any *Year* either past, present, or to come. Its use is very easie: For if you desire to know the Motion of the *Equinox* for any number of *Years*, you need but seek your number in the Column of *Years*, and against it you have the *Degrees* and *Minutes* of the *Equinoctial Motion*.

But though the *Stars* have this Motion one way, *viz.* in *Longuitude*, yet do they not at all alter their *Latitude*; Because the Motion of the *Equinoctial* is made upon the *Poles* of the *Ecliptick*.

§ IV.

## § IV. *Of the* Ecliptick.

The *Ecliptick* is a Great Circle, lying oblique or aſlope from the *Equinoctial*, making an Angle of 23½ Degrees with it: It cuts the *Equinoctial* into two equal parts, and is cut by the *Equinoctial* in two oppoſite points, *viz.* in ♈, and ♎. It divides the *Globe* into two equal parts, called *Hemiſpheares*; the one the *Northern*, and the other the *Southern Hemiſphear.* It is divided into 12 equal Parts, which are called the twelve *Signs*; every part being noted with the Character of the *Sign* belonging unto it, as unto *Aries*, ♈, to *Taurus*, ♉, to *Gemini*, ♊, and ſo of the reſt. From every one of theſe 12 diviſions proceed both ways, *viz. North*, and *South*, *Circles* of *Longitude*, into the *Poles* of the *Ecliptick*. Each of theſe 12 *Signs* is divided into 30 equal parts, which are called *Degrees*; and are numbred upon every tenth *Degree* with 10, 20, to 30, and upon my new *Cæleſtial Globe* for more preciſeneſs, every *Degree* is again divided into halfs.

" It is called the Ecliptick as being derived from the Greek " word *Eklepſin*, which ſignifies to want Light: Becauſe in " and about it happen all the defects and *Eclipſes* both of the " *Sun* and the *Moon.*

" It is alſo called *the way of the Sun*, becauſe the *Sun* goes al- ' ways under it, paſſing through it in all his *Annual* Courſe.

## § V. *Of the* Poles *of the* Ecliptick.

There are two *Poles* of the *Ecliptick*, the one the *North Pole*, the other the *South Pole*; and are called *North* or *South* according to their poſition next the *North* or *South Pole* of the World. Each is diſtant from its correſpondent *Pole* of the *World* 23 *Degrees*, 30 *Minutes.*

As on the *Terreſtrial Globe*, all the *Meridians* deſcribed thereon meet in the *Pole* of the *World*, ſo on the *Cæleſtial* all the *Circles* of *Longitude* drawn through the *Twelve Signs* meet in the *Poles* of the *Ecliptick.*

§ VI.

## § VI. *Of the* Axis *of the* Ecliptick.

Through the *Poles* of the *Ecliptick* is imagined to pass a streight line through the Center of the Plain of the *Ecliptick*: which is called *the Axis of the Ecliptick*, upon which the *Second Motion* of the *Ecliptick* is performed, even as the *Diurnal Motion* is performed upon the *Axis* of the *World*.

## § VII. *Of the* Colures, *and* Cardinal Points.

There are two Great Circles cutting one another at right Angels in the *Poles* of the *World*, which are called the *Colures*. Each *Colure* receives an additional name from the point in the *Ecliptick* that it cuts; as the one passes from *Pole* to *Pole* through the beginning of ♈ and ♎, which being two *Equinoctial Signs*, names therefore that *Colure* the *Equinoctial Colure*: The other passes through the beginning of ♋ and ♑, which are *Solstitial Signs*, and therefore names that the *Solstitial Colure*.

These *Colures* by intersecting one another, divide themselves into four Semi-circles; and these Semi-circles divide the *Ecliptick* into four equal parts, viz. ♈, ♋, ♎, and ♑.

The point of the *Ecliptick* that these intersections pass through, are called the four *Cardinal Points*; and are of great use in *Astronomy*: for according to the *Suns* approach to any of them, the Season of the Year is altered into *Spring*, *Summer*, *Autumn*, *Winter*: As shall be shewed hereafter.

## § VIII. *Of the* Tropicks.

There are two smaller Circles Parallel to the *Equinoctial*, which are called the *Tropicks*, the one called the *Tropick* of *Cancer*, the other the *Tropick* of *Capricorn*: They are distant from the *Equinoctial* 23 *Degrees* 30 *Minutes*; and therefore are the bounds of the *Ecliptick*. They receive their names from the *Cœlestial Sign* that they are joyned unto; as the one the *Tropick* of *Cancer*, because it touches the *Sign* of *Cancer*; the other the *Tropick* of *Capricon*, because it touches the *Sign* of *Capricorn*.

§ IX.

## § IX. *Of the Circles* Arctick *and* Amarctick.

About the *Poles* of the *World* are deſcribed two ſmall Parallel *Circles*; the one called the *Arctick*, the other the *Antarctick*. That in the *North* is called the *Arctick Circle*, that in the *South* the *Antarctick Circle*.

They have the ſame diſtance from the *Poles* of the *World* that the *Tropicks* have from the *Equinoctial Circle* (*viz.* 23 *Degrees* 30 *Minutes*) and that the *Ecliptick* hath from the *Poles* of the *World*; and therefore run through the *Poles* of the *Ecliptick*.

## § X. *Of the* Images *called* Conſtellations, *drawn upon the* Celeſtial Globe.

Here I think fit to be beholden to Dr. *Hood*, for the pains he hath taken in his Comment or the *Images* and *Conſtellations*. He ſaith, The *Stars* are brought into *Conſtellations* for inſtructions ſake: things cannot be taught without Names; to give a Name to every *Star* had been troubleſome to the Maſter, and for the Scholar; for the Maſter to deviſe, and for the Scholar to remember: and therefore the *Aſtronomers* have reduced many *Stars* into one *Conſtellation*, that thereby they tell the better where to ſeek them; and being ſought, how to expreſs them.

All the *Conſtellations* formerly notified by the Ancients were in number 48, twelve whereof we call *the twelve Signs* of the *Zodiack*, *viz.* 1 *Aries*, ♈, 2 *Taurus*, ♉, 3 *Gemini*, ♊, 4 *Cancer*, ♋, 5 *Leo*, ♌, 6 *Virgo*, ♍, 7 *Libra*, ♎, 8 *Scorpio*, ♏, 9 *Sagittarius*, ♐, 10 *Capricorn*, ♑, 11 *Aquarius*, ♒, 12 *Piſces*, ♓. One and twenty more are placed in the *North* Hemiſphere, and are called 1 *Urſa minor*, 2 *Urſa major*, 3 *Draco*, 4 *Cepheus*, 5 *Bootes*, 6 *Corona Septentri*, 7 *Hercules*, 8 *Lyra*, 9 *Cygnus*, 10 *Caſſiopea*, 11 *Perſeus*, 12 *Auriga*, 13 *Serpentarius*, 14 *Serpens Ophiuchi*, 15 *Sagitta*, 16 *Aquila*, 17 *Delphinus*, 18 *Equiculus*, 19 *Pegaſus*, 20 *Andromeda*, 21 *Triangulum*. The other 15 are Situate in the *South* Hemiſphere, and called 1 *Cetus*, 2 *Orion*, 3 *Eridanus*, 4 *Lepus*, 5 *Canis major*, 6 *Canicula*, 7 *Argo Navis*, 8 *Hydra*, 9 *Crater*, 10 *Corvus*, 11 *Centaurus*, 12 *Lupus*, 13 *Ara*, 14 *Corona Auſtrina*, 15 *Piſces Auſtrina*. Beſides, there are two other *Conſtellations* in the *North* Hemiſphere, *viz.* *Antinous*,

and *Coma Berenices*: which because they were not specified by the Ancients, are here inserted apart.

Now the *Astronomers* did bring them into these Figures, and not into other, being moved thereto by these three Reasons: First, these Figures express some properties of the *Stars* that are in them; as those of the *Ram* to be Hot and Dry; *Andromeda* chained betokeneth Imprisonment: the Head of *Medusa* cut off, signifies the loss of that part: *Orion* with his terrible and threatning gesture, importeth Tempest and terrible effects: The *Serpent*, the *Scorpion*, and the *Dragon* signify Poyson: The *Bull*, insinuateth a Melancholly passion: The *Bear* inferreth Cruelty, *&c.* Secondly, the *Stars* (if not precisely, yet after a sort) do represent such a Figure, and therefore that Figure was assigned them: as for Example, the *Crown*, both *North* and *South*; the *Scorpion* and the *Triangle*, represent the Figures which they have. The third Cause was, the continuance of the Memory of some notable Men, who either in regard of their singular pains taken in *Astronomy*, or in regard of some other notable deed, had well deserved of Mankind.

The first Author of every particular *Constellation* is uncertain; yet are they of great Antiquity; we receive them from *Ptolomy*, and he followed the *Platonicks*; so that their Antiquity is great. Moreover, we may perceive them to be Ancient by the *Scriptures*, and by the *Poets*. In the 38. *Chapter* of *Job* there is mention made of the *Pleiades*, *Orion*, and *Arcturus*, and *Mazzaroth*, which some interpret the 12 *Signs*: *Job* lived in the Time of *Abraham*, as *Syderocrates* maketh mention in his Book *de Commensurandis locorum distantiis*.

Now besides all this, Touching the reason of the invention of these *Constellations* the *Poets* had this purpose, *viz.* to make Men fall in love with *Astronomy*. And to that intent have to every *Constellation* invented strange conceited *Stories*; (as you may read at the latter end of this Book) therein imitating *Demosthenes*, who when he could not get the People of *Athens* to hear him in a matter of great moment, and profitable for the Commonwealth, he began to tell them a Tale of a Fellow that sold an *Ass*; by which Tale, he so brought on the *Athenians*, that they were both willing to hear his whole Oration, and to put in Practice what he exhorted them to. The like intent had the *Poets* inventing of these *Stories*: They saw that *Astronomy* being

ing for commodity singular in the life of Man, was almost of all Men utterly neglected: Hereupon they began to set forth that Art under *Fictions*; that thereby, such as could not be perswaded by Commodity, might by the pleasure be induced to take a view of these Matters: and thereby at length fall in love with them. For commonly you shall note this, that he that is ready to Read the *Stories*, cannot content himself therewith, but desireth also to know the *Constellation*, or at leastwise some principal *Star* therein.

There are in *Heaven* yet twelve *Constellations* more, posited about the *South Pole*, which were added by *Frederico Houtmanno*, inhabiting on the Island *Sumatra*; who being accommodated with the Instruments of immortal *Tycho*, hath observed the *Longitude* and *Latitude* of those *Stars*, reduced them into *Constellations*, and named them as follows, 1 The *Crane*, 2 The *Phenix*, 3 The *Indian*, 4 The *Peacock*, 5 The *Bird of Paradise*, 6 The *Fly*, 7 The *Camelion*, 8 The *South Triangle*, 9 The *Flying Fish*, 10 *Dorado*, 11 The *Indian Fowl*, 12 The *Southern Serpent*.

## § XI. *Of the number of the* Stars.

Although in *Heaven* there be a very great number of visible *Stars*, which for their multitude seem innumerable; yet no wise Man will from thence infer that they are impossible to be counted: for there is no *Star* in *Heaven* that may be seen, but its *Longitude* and *Latitude* may with meet Instruments for that purpose be exactly found; and being once found, it may have a Name allotted it, which with its *Longitude* and *Latitude* may be Catalogized either for the Memory of the Observer, or the knowledge of Posterity. Now therefore if any one *Star* may be Observed, they may all be Observed; and then may they all have Names given them; which though to the ignorant it seem uncredible, yet to the Sons of God (as *Josephus* calls *Astronomers*) who herein participate of their Father's knowledge, it is easie to *number the Stars, and call them all by their Names*, Psal. 97.4.

But though all the *Stars* in *Heaven* may be numbred and named, yet hath not *Tycho*, or the Ancient *Astronomers*, thought fit to take notice of more than 1241 of the chiefest that are visible of our *Horizon*, they being sufficient for any purpose that we shall have occasion to apply them unto. You of late

the industry of *Fred. Houtman* aforesaid, hath added to the Catalogue 136 *Stars*, with their *Longitude*, *Latitude*, and *Magnitude*, and given Names unto them: which upon my New *Globes* I have also ascerted, as may be seen about the *South Pole* thereof. So that with these 1241 Observed by *Tycho* and the Ancients, and these 136, the whole number of the Catalogue is 1377.

Some other *Stars* of late have been also observed by *Baierus*, among the several *Constellations* aforesaid; but not of any considerable *Magnitude*: and therefore I think fit to pass them by, and come to their Situation in *Heaven*, according to *Longitude* and *Latitude*.

## § XII. *Of the Situation of the* Stars.

Longitude of the Stars.

The *Stars* are Situate in *Heaven* according to their *Longitude* and *Latitude*. As the *Longitude* of any Place on the *Terrestrial Globe* is an Arch of the *Equator* comprehended between the first *Meridian* and the Place; so the *Longitude* of any *Star* on the *Celestial Globe* is an Arch of the *Ecliptick* contained between the first point of *Aries* and the *Star* inquired after. But yet because the *Ecliptick* is divided into 12 *Signs*, the *Longitude* of a *Star* is therefore (in the most customary Account) an Arch of the *Ecliptick* comprehended between the Semi-circle of *Longitude*, passing through the beginning of the *Sign* the *Star* is in, and the Semi-circle of *Longitude* passing through the Center of the *Star*.

Latitude of the Stars.

The *Latitude* of a *Star* is either *North* or *South*: *North*, if on the *North* side of the *Ecliptick*; *South* if on the *South* side of the *Ecliptick*. As the *Latitude* of any Place on the *Terrestrial Globe* is an Arch of the *Meridian* contained between the *Equator* and the *Parallel* of the Place, so is the *Latitude* of any *Star* on the *Celestial Globe* an Arch of a *Semi-circle* of *Longitude*, comprehended between the *Ecliptick* and the *Star* inquired after.

## § XIII. *Of the* Magnitudes *of the* Stars.

For the better distinction of the several sizes of *Stars*, they are divided into six several *Magnitudes*. The biggest and brightest *Stars* are called *Stars of the first Magnitude*: Those one

one ſize inferiour in Light and Bigneſs are called *Stars of the Second Magnitude*; Thoſe again one ſize inferiour to the *Stars* of the *Second Magnitude*, are called *Stars of the Third Magnitude*, and ſo the *Stars* gradually decreaſe unto the *Sixth Magnitude*, which is the ſmall, ſome few Obſcure *Stars* only excepted, which for their minority and dimneſs are called *Nebula*. Theſe ſeveral *Magnitudes* of the *Stars* are expreſſed on the *Globe* in ſeveral ſhapes: as may be ſeen in a ſmall Table placed on the *Globe* for that purpoſe.

Now for your further ſatisfaction and delight, I have inſerted a Collection of Dr. *Hood*'s, wherein is expreſſed the Meaſure of every *Magnitude*, and the Proportion it hath, firſt, to the *Diameter*, and ſecondly, to the *Body* of the *Earth*. The Meaſures of the ſeveral Stars.

The greatneſs of any thing (ſaith he) cannot be better expreſſed than by comparing it to ſome common Meaſure, whoſe quantity is known: the Common Meaſure whereby *Aſtronomers* expreſs the greateſt of the *Stars*, is the *Earth*.

Sometimes they compare them with the Diameter of the *Earth*, ſometimes with the *Globe* thereof: The Diameter, according to their account, which allow but 60 *Miles* to a Degree, containeth $6822\frac{8}{11}$ *Miles*; and the whole Solidity of the *Globe* contains 165, 042, 481, 238 *Miles* and $\frac{1}{11}\frac{8}{7}$. According to *Ptolomy*, who allotteth to every Degree $62\frac{1}{2}$ *Miles*: The Diameter containeth 7159 *Miles* $\frac{1}{11}$, and the whole Solidity of the *Globe* hath 192, 197, 184, 917 $\frac{4}{1}\frac{7}{3}\frac{3}{1}$ *Miles*.

## *The proportion of the Diameters of the* fixed Stars, *compared with the Diameter of the* Earth.

The Diameter of a *Fixed Star* of the *Firſt Magnitude* compared with the Diameter of the *Earth* hath ſuch Proportion to it as 19 hath to 4: therefore it containeth the Diameter of the *Earth* 4 times and $\frac{3}{4}$.

The Diameter of a *Star* of the *Second Magnitude* is unto the Diameter of the *Earth* as 269 is to 60: therefore it containeth it $4\frac{3}{6}\frac{9}{0}$ times.

The Diameter of a *Fixed Star* of the *Third Magnitude* is unto the Diameter of the *Earth* as 25 unto 6: therefore it containeth it $4\frac{1}{5}$ times.

The Diameter of a *Fixed Star* of the *Fourth Magnitude* is unto the

the Diameter of the *Earth* as 19 and 5: therefore it containeth it $3\frac{4}{7}$ times.

The Diameter of a *Fixed Star* of the *Fifth Magnitude* is unto the Diameter of the *Earth*, as 119 unto 36, therefore it containeth it $3\frac{11}{36}$ times.

The Diam. of a *Fixed Star* of the *Sixth Mag.* is unto the Diam. of the *Earth*, as 21 unto 8; therefore it containeth it $\frac{1}{8}$ times.

As for the Proportions of the Cloudy and Obscure *Stars*, they are not expressed; because they are but few, and of no great account in respect of their smalness.

*The Proportions of the* Fixed Stars *compared with the* Globe *of the* Earth, *are as follow.*

A *Star* of the *First Magnitude* is to the *Globe* of the *Earth*, as 6859 to 64, therefore it containeth the *Globe* of the *Earth* $107\frac{1}{8}$ times.

A *Star* of the *Second Magnitude* is to the *Globe* of the *Earth*, as 1946 5109 is to 216000, therefore it containeth it $90\frac{1}{8}$ times.

A *Star* of the *Third Magnitude* is to the *Globe* of the *Earth*, as 15625 is to 216, therefore it containeth it $72\frac{1}{3}$ times.

A *Star* of the *Fourth Magnitude* is to the *Globe* of the *Earth*, as 6850 is unto 125: therefore it containeth the *Globe* of the *Earth* $54\frac{1}{4}$ times.

A *Star* of the *Fifth Magnitude* is to the *Globe* of the *Earth*, as 1685159 is unto 46656, therefore it containeth the *Globe* of the *Earth* $36\frac{1}{4}$ times.

A *Star* of the *Sixth Magnitude* is to the *Globe* of the *Earth*, as 9261 is unto 512, therefore it containeth the *Globe* of the *Earth* $18\frac{1}{10}$ times.

I confess all this may seem matter of incredulity to those whose understanding is swayed by their visual Sence, but if they be capable to consider the vast distance of those Huge Bodies (the *Stars*) from the face of the *Earth*, and also the diminutive quality of Distance, their reason will be rectified, and their incredulity turn'd into an acknowledgment of the unspeakable Wisdom of Almighty God; and they will say with the *Psalmist*, *Great is our Lord, Great is his Power, his Wisdom is infinite, Psal.* 147. 5.

The distance of the *Stars* therefore from the *Earth*, is according to Mr. *John Dee*'s Computation, 2008 $1\frac{1}{2}$ Semidiameters

ters of the *Earth*. The Semidiameter of the *Earth* containeth of our common *Miles* $3436\frac{4}{11}$, Such *Miles* as the whole *Earth* and *Sea* round about is 21600: allowing for every *Degree* of the greateſt *Circle* 60 *Miles*: ſo that the diſtance of the *Stars* from the *Earth* is in Miles 69006540. Now as Mr. *Dee* ſaith (almoſt in the ſame words) if you weigh well with your ſelf this little parcel of Fruit *Aſtronomical*; as concerning the Bigneſs and Diſtance of the *Stars*, &c. and the huge maſſineſs of the *Starry Heaven*, you will find your Conſciences moved with the Kingly Prophet to ſing the Confeſſion of God's Glory; and ſay, *The Heavens declare the Glory of God, and the Firmament ſheweth forth the Works of his Hands.*

## § XIV. *Of the* Nature *of the* Stars.

To many of the Principal *Stars* there is in *Planetical* Characters prefixed their *Planetical Natures*. The *Aſtrologers* make great uſe of them for knowing the *Nature* of the *Stars*: for thoſe *Stars* that have the Character of ♄ adjoyned, are ſaid to be of the *Nature* of ♄: thoſe that have ♃ adjoyned, are of the *Nature* of ♃: and ſo of the reſt. If a *Star* have the Characters of two *Planets* adjoyned, that *Star* participates of both their *Natures*, but moſt of that *Planets* whoſe character is firſt placed.

The uſe *Aſtronomers* make of thoſe Characters, is for knowing the Colour of any *Star*; as if a *Star* have ♄ adjoyned, it is of the Colour of ♄; if ♃, it is the Colour of ♃, &c.

The *Fixed Stars* are known from the *Planets* by their continual Twinkling, for the *Planets* never Twinkle, but the *Fixed Stars* do.

## § XV. *Of* Via Lactea, *or the* Milky way.

This Subject, becauſe it is already ſo fully handled by Dr. *Hood*, that more than he hath Written cannot well be ſaid, either of his own Opinion or other Mens, I think fit therefore to give you his own Words, which are as follow,

VIA LACTEA, or *Circulus Lacteus* by the *Latines* ſo called; and by the *Greeks*, *Galaxia*, and by the *Engliſh* the *Milky way*. It is a broad white Circle that is ſeen in the *Heaven*: In the *North Hemiſphere*, it beginneth at *Cancer*, on each ſide the Head thereof, and paſſeth by *Auriga*, by *Perſeus*, and *Caſſiopeia*, the *Swan*, and the Head of *Capricorn*, the Tail of *Scorpio*, and

and the Feet of *Centaur*, *Argo* the *Ship*, and so unto the Head of *Cancer*. Some in a sporting manner do call it *Watling-Street*, but why they call it so, I cannot tell; except it be in regard of the narrowness that it seemeth to have; or else in respect of that great High-way that lieth between *Dover* and St. *Albans*, which is called by our Men *Watling-Street*.

Concerning this Circle there are sundry Opinions; for there is great difference among some Writers, both touching the Place, Matter, and Efficient Cause thereof. *Aristotle* dissenteth from all other, both *Philosophers* and *Poets*, in the *Place*, *Matter*, and *Cause* of this Circle; saying, That it is a *Meteor* ingendered in the *Air*, made of the *Vapours* of the *Earth*, drawn up thither by the Heat of the *Sun*, and there set on *Fire*. But his Opinion is of all Men confuted.

First, Touching the Place, it cannot be in the *Air*; for whatsoever is in the *Air*, is not seen of all Men, at all Times, to be under one and the same Part of *Heaven*. If we see it in the *South*, they that are in the *West* shall see it under the *East* side of the *Heaven*, and they that are in the *East*, shall see it in the *West* Part of the *Heaven*; But this Circle is of all Men seen always under the same Part of *Heaven*, and to be joyned with the same *Stars*; therefore it cannot be in the *Air*.

Again, for the *Matter*, it cannot be made of that which *Aristotle* nameth (*i.e.*) the *Vapours* of the *Earth*, because of the long continuance of the Thing, and that without any Alteration: for it is impossible that any *Meteor* made of *Vapours* drawn up from the *Water*, or *Exhalations* from the *Earth*, should last so Long; as may be seen in *Blazing Stars*; which though they have continued long, as namely 16 Months, some more, some less; yet at the length they have vanished away: whereas this Circle hath continued from the Beginning unto this Day. Besides, put case it were made of these *Exhalations*; whence will they infer the uniformity thereof? The *Comets* do alter diversly, both in the Fashion of their Blazing, and also in their several Quantities; whereas in this Circle, there is nothing but the same Part, always of one Form and of one Bigness. In the Efficient Cause thereof he must needs err: for if it be neither in the *Air*, nor made of the Exhalations of the *Earth*, it cannot be caused by the *Sun*; for the one is the Place, and the other the Matter, wherein, and whereupon the *Sun* sheweth his power.

All

All other (beſides *Ariſtole*) agree in the Place, but differ in the Efficient cauſe thereof; and they are either *Philoſophers*, or *Poeti*. Both theſe affirm that it is in the *Firmament* (i.e.) in the *Eight Sphere*, but they diſagree in the Cauſe thereof.

The *Philoſophers* (and chiefly *Democritus*) affirm the Cauſe of the thing, to be the exceeding great number of *Stars* in that part of *Heaven*, whoſe Beams meeting together ſo confuſedly, and not coming diſtinctly to the Eye, cauſeth us to imagine ſuch a Whiteneſs as is ſeen. But the beſt Opinion is this, that this *Milky way* is a part of the *Firmament*, neither ſo thin as the other parts thereof are, nor yet ſo thick as the *Stars* themſelves. If it were as thin as the other Parts of the *Heaven* beſides the *Stars*, then could it not retain the light, but the light would paſs through it and not be ſeen: If it were as Thick as the *Stars*, then would the Light be ſo doubled in it, that it would Gliſter and Shine, as the *Stars* themſelves do: but being neither ſo thin as the one, nor ſo thick as the other, it becometh of that Whiteneſs we ſee. Thus far Dr. *Hood*, But

Our modern Philoſophers conceive this *Lacteau* Whiteneſs ariſeth from a great number of little Stars, conſtipated in that part of *Heaven*; flying ſo ſwiftly from the ſight of our Eyes, that can perceive nothing but a confuſed Light; this is *Teleſcope* (more lately found out) doth evidently demonſtrate to us; by the Benefit of which, little Stars (otherwiſe inconſpicuous to our Eyes) are there clearly diſcerned.

About the Southern Pole are ſeen two *White Spots*, like little *Clouds*, coloured like the *via Lactea*, one of which is treble the *Latitude* of the other; ſome *Mariners* call them *Nubeculæ Magellani*.

This *Milkey way* is deſcribed on the *Globe* between two Tracks of ſmall Pricks running through the *Images* mentionned in the beginning of this Section.

Thus have you the definition of the *Globes*, with the Deſcription of all the *Lines*, *Circles*, &c. deſcribed thereon. I ſhall now explain unto you the meaning of ſeveral Words of Art, which in the Uſe of them you will meet with, and then come to the uſe it ſelf.

And firſt, what is meant by the word *Horizon*.

## § XVI.

When I spake of the *Horizon* before, I only mentioned the Wooden *Horizon*, or Frame about the *Globe*; which because it represents the *Mathematical Horizon*, is therefore called the *Horizon*; but the word *Horizon* is to be considered more particularly two manner of ways: as

First, the *Natural Horizon*.

Secondly, the *Mathematical Horizon*.

The *Natural Horizon* is that apparent Circle which divides the Visible part of *Heaven* from the Invisible; it extends it self in a straight Line from the Superficies of the *Earth*, every way round about the place you stand upon, even into the very circumference of the *Heavens*. It is only discerned at *Sea*, or on plain Ground, that is free from all hindrance of the Sight, as *Hills*, *Trees*, *Houses*, &c.

The *Mathematical Horizon* (which indeed is meant in this Treatise, so oft as I shall have occasion to name the word *Horizon*) is a great Circle which divides that part of *Heaven* which is above us, from that which is under us, precisely into two equal parts; whose *Poles* are the *Zenith* and *Nadir*. In this Circle the *Azimuths* or *Vertical Circles* are numbred, and by this Circle our *Days* and *Nights* are measured out unto us; for while the *Sun* is above the *Horizon* it is *Day*; and when it is under the *Horizon* it is *Night*.

This Circle is represented unto us by the upper Plain of the Wooden *Horizon*: Therefore so oft as you are directed to bring any *Degree* or *Star*, &c. to the *Horizon*, it must be understood that you must turn the *Globe* till the *Degree* or *Star* come just to the upper Inner edge of the Wooden *Horizon*.

*Zenith.* The *Zenith* and *Nadir* are two points opposite to one another. The *Zenith* is that point in *Heaven* directly over our Heads; and the *Nadir* is that point in *Heaven* directly under our Feet.

*Nadir.*

*Azimuth, or Vertical Circles.* The *Azimuths*, or *Vertical Circles*, are great Circles, passing through the *Zenith* and *Nadir*, whose *Poles* are the *Zenith* and *Nadir*. And as the *Meridians* cut the *Equator* and all Parallels to the *Equator* at right Angles, so the *Azimuths* cut the *Horizon* and all *Almicanthars* at right Angles also. The *Azimuths* (as the *Meridians*) are infinite; and are numbered by *Degrees* from the *East* and *West* points towards the *North* and *South* in the *Horizon*.

The

The *Almicanthars* are Circles parallel to the *Horizon*, whose *Poles* are the *Zenith* and *Nadir*. They are so called *Circles of Altitude*, because when the *Sun*, *Moon*, or any *Star* is in any number of Degrees above the *Horizon*, it is said to have so many Degrees of *Altitude*; which Degrees of *Altitude* are numbred on the *Vertical Circle* from the *Horizon* upwards, towards the *Zenith*. The *Almicanthars* are also infinite, as *Parallels*, *Meridians* and *Azimuths* are. *Almicanthars, or, Circles of Altitude.*

The *Amplitude* is the number of Degrees contained between the true *East* or *West* point towards the *North* or *South* points of the *Horizon*, and the *Rising* or *Setting* of the *Sun*, *Moon*, or *Stars*, &c. *Amplitude.*

The *Declination* is the number of Degrees that the *Sun*, *Moon*, or any *Star* is distant from the *Equinoctial* towards either *Pole*, and hath a double denomination, *viz. North Declination*, and *South Declination*; for if the *Sun*, *Moon*, or *Stars* swerve towards the *North Pole*, they are said to have *North Declination*, if towards the *South Pole*, *South Declination*. *Declination.*

The *Right Ascension* is the number of Degrees of the *Equinoctial* (accounted from the first point of *Aries*) which comes to the *Meridian* with the *Sun*, *Moon*, or *Stars*, or any other point in *Heaven* proposed. *Right Ascension*

The *Oblique Ascension* is the number of Degrees of the *Equinoctial* which comes to the *East* side the *Horizon* with the *Sun*, *Moon*, or any *Star*. *Oblique Ascension.*

The *Oblique Descension* is the Degrees of the *Equinoctial*, which comes to the *West* side the *Horizon* with the *Sun*, *Moon*, or any *Star*. *Oblique Descension.*

The *Ascensional Difference* is the number of Degrees after Substraction of the *Oblique Ascension* from the *Right Ascension*. *Ascensional Difference.*

So many Degrees as you Sail towards the *Pole*, you are said to *Raise the Pole*; and so many Degrees as you Sail from the *Pole*, you are said to *Depress the Pole*. *Raise the Pole Depress the Pole*

*Course* is the *point of the Compass* you Sail upon; as if you Sail *Eastward*, it is an *Easterly Course*, if *West*, a *Westerly Course*, &c. *Course.*

*Distance* is the number of *Leagues* you have Sailed from any place, upon any *Course*. *Distance.*

A *Zone* is a space of the *Earth*, contained between two *Parallels*. The Ancient *Geographers* made five *Zones* in the *Earth*; two *Frozen*, two *Temperate*, and one *Burnt Zone*. *Zone.*

*Frozen Zone.* The two *Frozen Zones* are those parts of the *Globe* comprehended between the *North Pole* and the *Antarctick Circle*, and the *South Pole* and the *Antarctick Circle*; by the Ancients called *Inhabitable*, because the *Sun* being always far remote from them shoots its Beams obliquely upon them, which oblique Beams are so very weak, that all their *Summer* is but a continued *Winter*, and the *Winter* (as they thought) impossible to be at all indured.

*Temperate Zone* The *Temperate Zones* are the space of *Earth* contained between the *Arctick Circle* and the *Tropick of* ♋, and the *Antarctick Circle* and the *Tropick of* ♑, by the Ancients called *Temperate* and *Habitable*; because they are composed of a sweet mediocrity, between outragious Heat, and extremity of Cold.

*Burnt Zone.* The *Burnt Zone* is the space of *Earth* contained between the *Tropick* of ♋, and the *Tropick* of ♑, called by the Antients *Inhabitable*, because in regard the *Sun* never moves out of this *Zone*, but darts is Beams perpendicularly upon it, they imagined the Air was so unsufferable Hot, that it was impossible for any to Inhabit in this *Zone*; so that (as you see) they held the two *Temperate Zones* only habitable, and the two *Frozen Zones* and one *Burnt Zone* altogether impossible to be Inhabited. But their Successors, either animated by industry, or compelled by necessity, have apparently refuted their Assertion; for at this time many thousands can witness that their Bloods are not so greasie as to Melt in the scorching Heat of the One, or so Watry as to Congeal in the *Icy* Frosts of the other.

*Climates.* The Antients have yet otherwise divided the *Earth* into four and twenty *Northern Climates*, and four and twenty *Southern Climates*; so that in all there is eight and forty *Climates*. The *Climates* are altered according to the half Hourly increasing of the longest Days; for in the *Latitude* where the longest Days are increased half an Hour longer than they are at the *Equator* (viz. longer than 12 Hours) the first *Climate* begins; and in the *Latitude* where they are increased an whole Hour longer than in the *Equator*, the second *Climate* begins, where the days are increased three half hours longer than in the *Equator*, the third *Climate* begins; and so onwards, the *Climates* alter according as the longest Day increases half an Hour, till you come to find the longest day 24 Hours long.

Now the Antients (in those Times) knowing no more than nine *Habitable Climates*, gave names only to nine. The first they

they called *Dia Meroe*, after the name of a famous Inland Island, which is situate about the middle of that *Climate*, and is now called *Gueguere*. The second *Climate* they called *Dia Syenes*, after the name of an eminent *City* in *Ægypt*, lying about the midst of that *Climates*. The third *Dia Alexanderas*, after the name of the Metropolitan *City* of *Ægypt*. The fourth *Dia Rhodes*. The fifth *Dia Rhomes*. The sixth *Dia Ponton*. The seventh *Dia Boristheneos*. The eighth *Dia Ripheos*. The ninth *Dia Daniam*.

These Names belong only to the *Climates* on the *North* side of the *Equator*. But those on the *South* side (in regard of the small *Discoveries* those Ages had on that side the *Equator*) were distinguisht only by the addition of the word *Anti*, to the same *Southerly Climate*; as the first *Southern Climate* (which is that *Climate* that lies as many Degrees to the *Southward* as the first doth to the *Northward*) they called *Anti Meroes*. The second *Anti Syenes*. The third *Anti Alexanderas*, and so on to the ninth.

In every *Climate* is included two *Parallels*, which are of the same Nature with the *Climates*; save only that as the *Climates* alter by the half hourly increasing of the longest day, the parallels alter by the Quater Hourly increasing of the longest Day. *Parallels.*

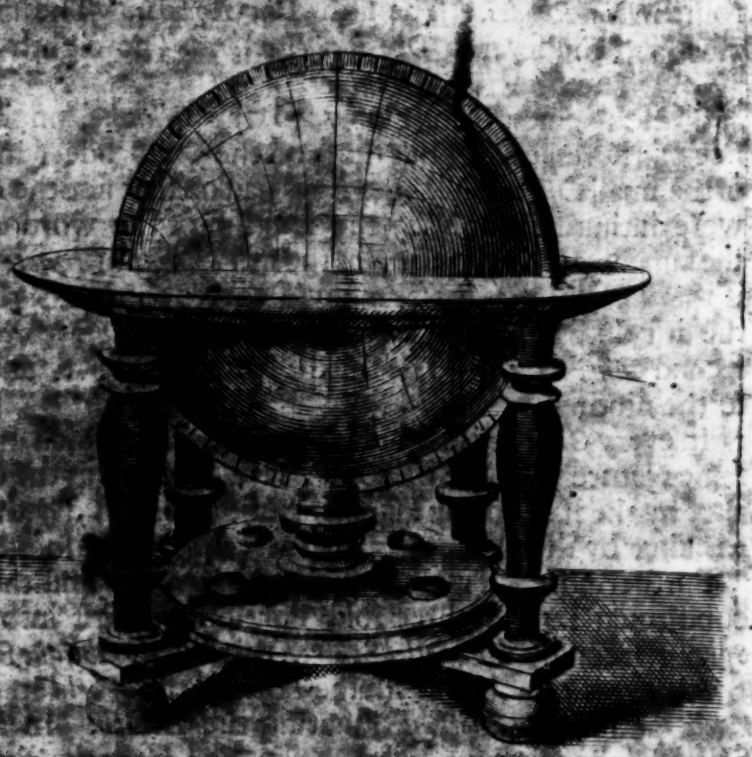
Furthermore, in respect of the *Horizon*, we find the *Sphere* constituted into a three-fold Position; as first into a *Direct Sphere*, secondly a *Parallel Sphere*, thirdly an *Oblique Sphere*.

A *Direct Sphere* hath both the *Poles* of the *World* in the *Horizon*, and the *Equinoctial* transiting the *Zenith*. In a *Direct Sphere* all the Circles parallel to the *Equator* make right Angles with the *Horizon*, and are also divided into two equal parts by the *Horizon*; and in a *Direct Sphere* the *Sun*, *Moon*, and *Stars* are always twelve Hours above the *Horizon*, and twelve Hours under the *Horizon*, and consequently make twelve Hours Day, and twelve Hours Night. *Direct Sphere.*

It is called a *Direct Sphere*, because all the *Celestial* Bodies, as *Sun*, *Moon*, and *Stars*, &c. by the *Diurnal* Motion of the *Primum Mobile*, ascend directly Above, and descend directly Below the *Horizon*.

They that Inhabit under the *Equator*, have the *Sphere* thus posited; as in the Island *Borneo*, *Sumatra*, *Celebes*, St. *Thomas*, a great part of *Africk*, *Peru* in the *West-Indies*, &c. as you may see

ſee by the *Globe* it ſelf; if you move the *Braſen Meridian* through the notches in the *Horizon*, till the *Poles* thereof touch the *Horizon*. As in the Figure.



*Parallel Sphere* A *Parallel Sphere* hath one *Pole* of the *World* in the *Zenith*, the other in the *Nadir*, and the *Equinoctial* line in the *Horizon*.

In a *Parallel Sphere*, all the Circles Parallel to the *Equinoctial*, are alſo Parallel to the *Horizon*, and in a *Parallel Sphere* from the 10*th.* of *March* to the 13*th.* of *September* (the *Sun* being then in the *Northerly Signs*, and conſequently on the *North* ſide the *Horizon*) there is ſix Months Day in the *North*, and ſix Months Night in the *South*; and contrarily from the 13 of *September* to the 10 of *March* (the *Sun* being then in the *Southerly Signs*, and therefore on the *South* ſide the *Horizon*) there

there is six Months Day in the *South*, and six Months Night in the North.

It is called a *Parallel Sphere*, Because the *Sun*, *Moon*, or *Stars* in a Diurnal Revolution of the *Heavens*, neither ascend Higher or descend Lower, but always move parallel to the *Horizon*.

The *Earth* is thus posited under both the *Poles*, viz. in 90 Degrees of *Latitude*; as may be seen by the *Globe*, if you turn the *Brazen Meridian* till either of the *Poles* be elevated 90 Degrees above the *Horizon*. As in this Figure.

An *Oblique Sphere* hath the *Axis* of the *World* neither *Direct* or *Parallel* to the *Horizon*, but lies a-slope from it. *Oblique Sphere.*

In an *Oblique Sphere* all the *Celestial* Bodies, as *Sun*, *Moon*, or *Stars*, &c. have (in respect of the *Horizon*) oblique and unequal Ascensions and Descensions, and all the Lines parallel to the *Equator*

*Equiator* make unequal Angles with the *Horizon*, and are cut by the *Horizon* into unequal parts; for those lines towards the elevated *Pole*, have a greater portion of a Circle under the *Horizon* than above it; only the *Equator* because it hath the same Center with the *Horizon*, doth divide the *Horizon* into two equal parts, and is also divided into two equal parts by the *Horizon*.

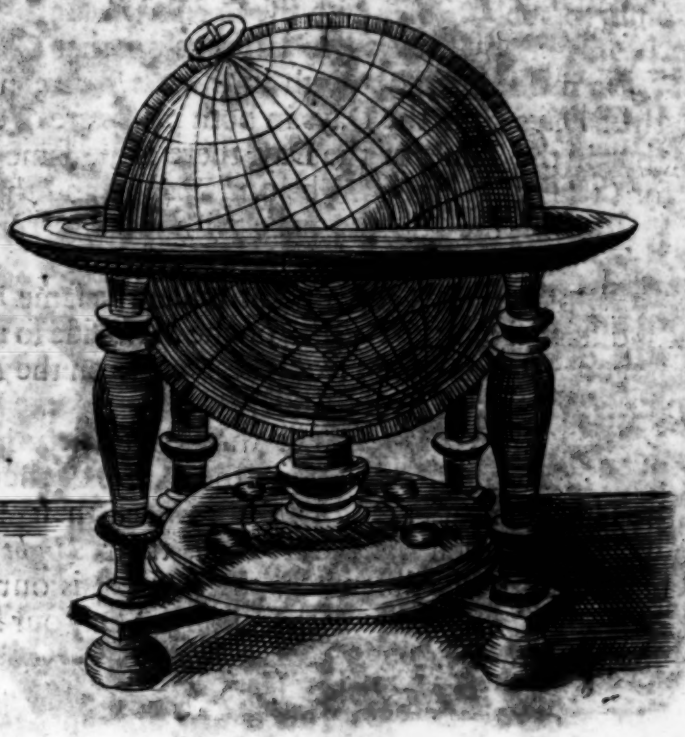
Hence it follows, that when the *Sun* is in any part of the *Ecliptick* that declines towards the elevated *Pole*, the Days in the elevated *Hemisphere* shall be longer than the Nights; and when the *Sun* is in any part of the *Ecliptick* that Declines towards the depressed *Pole*, the Nights shall be longer than the Days. But when the *Sun* is in the *Equinoctial* (because whether the *Pole* be *Raised* or *Depressed*) equal portions remain both above and under the *Horizon*; therefore the Days are of the same length with the Nights, and the Nights with the Days.

Also in an *Olique Sphere*, all those *Stars* that have as great or greater number of Degrees of Declination than is the elevated *Poles* Complement of *Latitude* to 90, never set or come under the *Horizon*, and those *Stars* that have the same Declination about the *Depressed Pole*, never Rise.

It is called an *Oblique Sphere*, because all the Circles of the *Sphere* move Obliquely about the *Horizon*.

The *Earth* is thus obliquely posited to all those Nations that Inhabit under any Degree of *Latitude*, either *North* or *Southwards*, between the *Equator* and either *Pole*: as may variously be seen by the *Globe*, when the *Axis* lies not on the *Horizon*, nor the *Equator* is parallel to the *Horizon*; As in this following Figure.

Moreover



Moreover, all Places have their *Antipodes*, *Periæci* and *Antæci*.

The *Antipodes* of any Place is the oppoſite Degree on the *Globe*. As if a Perpendicular were let fall from the Place you ſtand on, through the Center of the *Earth*, and continued till it paſs quite through the Superficies of the *Earth*, on the other ſide; then in the point where the Perpendicular cuts the Superficies of the *Earth* on the other ſide, is the *Antipodes* of that Place.

The Inhabitants of any two Places that are in *Antipodes* to each other, go with their Feet directly againſt one another, and have a contrarity in the *Seaſons* of the Year, and *Riſings* and *Settings* of the *Sun*, *Moon*, or *Stars*, and all other of the *Heavenly* Bodies; ſo that when with Us it is *Spring*, with Them it is *Autumn*; when with Us the *Sun* Riſes, in our *Antipodes* it Sets; and therfore their *Morning* is our *Evening*, their *Noon* our *Mid-*

*night*, their *Evening* our *Morning*; and their Longeſt Day our Shorteſt.

The *Periæci* of any place is that point in the ſame *Parallel* which comes to the *Meridian* with the *Antipodes*.

In the *Periæci* of any Place there happens not that Contrariety of *Seaſons* in the Year that doth in the *Antipodes*; nor in the Length of Days; for the Days in both places are of equal Length; but in the Times of the Day, there is the ſame contrariety, for (though their *Spring* be our *Spring*) and the reſt of their Seaſons of the *Year* the ſame with ours, yet) their *Morning* is our *Evening*, their *Night* our *Day*, &c.

The *Antæci* of any Place is the point under the ſame *Meridian* that is diſtant from the *Equator* on the *South* ſide ſo many Degrees as your Place is diſtant from the *Equator* on the *North* ſide; and the contrary.

In the *Antæci* there happens not that contrariety in the Days as doth in the *Antipodes*, but in the *Seaſons* of the Year there is the ſame contrariety; for in our *Antæci* their *Morning* is our *Morning*, their *Noon* our *Noon*, their *Night* our *Night*; but herein is the difference, their *Spring* is our *Fall*, their *Summer* our *Winter*, &c. and their Longeſt Day our Shorteſt; as in the *Antipodes*.

The

# The SECOND BOOK:

## Shewing the Practical Uſe of the

# GLOBES.

## *Applying them to the Solution of* Aſtronomical *and* Geographical *Problems.*

## PREFACE.

### Some Advertiſements in *Chooſing* and *Uſing* the GLOBES.

1. *SEE the Papers be well and neatly paſted, on the* Globe; *which you may know, if the Lines and Circles deſcribed thereon meet exactly, and continue all the way even and whole; the Lines not ſwerving out or in, and the Circles not breaking into ſeveral Arches; nor the Papers either come ſhort, or lap over on the other.*

2. *See that the Colour be tranſparent, and lay not too thick on the* Globe; *leſt it hide the Superficial Deſcriptions.*

3. *See the* Globe *Hang evenly between the* Meridian *and* Horizon; *not inclining more to the one ſide than the other.*

4. *See the* Globe *Swim as cloſe to the* Meridian *and*

Horizon *as conveniently it may; leſt you be too much puzzled to find againſt what point of the* Globe *any Degree of the* Horizon *or* Meridian *is.*

5. *See the* Equinoctial Line *be one with the* Horizon, *when the* Globe *is ſet in a* Parallel Sphere.

6. *See the* Equinoctial Line *cut the* Eaſt *and* Weſt *point of the* Horizon, *when the* Globe *is ſet to an* Oblique Sphere.

7. *See the Degrees of the* Meridian *maked with* 90 *and* 00, *Hand exactly over the* Equinoctial Line *of the* Globe.

8. *See that exactly half the* Meridian *be above the* Horizon, *and half under the* Horizon; *which you may know if you bring any of the Decimal Diviſions to the* North *ſide of the* Horizon, *and find their Complement to* 90 *in the* South.

9. *See that when the* Quadrant of Altitude *is placed at the* Zenith, *the beginning of the Graduations reach juſt to the Superficies of the* Horizon.

10. *See that while the* Index *of the* Hour Circle (*by the motion of the* Globe) *paſſes from one* Hour *to the other,* 15 *Degrees of the* Equator *paſs through the* Meridian.

11. *If you have a* Circle of Poſition, *ſee the Graduations agree with thoſe of the* Horizon.

12. *See that your Wooden* Horizons *be made ſubſtantial and ſtrong; for (beſides the Inconveniencies that thin Wook is ſubject unto, in reſpect of warping and ſhrinking) I have had few* Globes *come to mending that have not had either brokes* Horizon, *or ſome other notorious fault occaſioned through the ſleightneſs of the* Horizon.

## In the Uſing of the Globes.

KEep *the* Eaſt *ſide of the* Horizon *always towards you, unleſs your Propoſition requires the turning of it; which* Eaſt *ſide you may know by the Word* Eaſt, *placed*

*ced on the outmoſt verge thereof. For then have you the graduated ſide of the* Meridian *always towards you, the* Quadrant of Altitude *before you, and the* Globe *divided into two equal parts.*

*So oft as I name* to, at, of *or* under the Meridian, *or* Horizon, *I mean the* Eaſt *ſide of the* Meridian, *and Superficies of the* Horizon; *becauſe the* Eaſt *ſide of the* Meridian *paſſes through the* North *and* South *points, both of the* Globe *and* Horizon; *and agrees juſt with the middle of the* Axis: *And the Superficies of the* Horizon *divideth the* Globe *exactly into two equal parts.*

*If you happen to uſe the* Globes *on the* South *ſide the* Equator, *you muſt draw the Wyers out of either* Pole, *and change them to the contrary* Poles; *putting the longeſt Wyer into the* South Pole.. *And becauſe on the other ſide the* Equator *the* South Pole *is elevated, therefore you muſt elevate the* South Pole *of the* Globe *above the* Horizon, *according to the* South Latitude *of your Place; as ſhall be ſhewed hereafter.*

*In the working ſome* Problems *it will be required that your turn the* Globe *to look on the* Weſt *ſide thereof; which turning will be apt to jog the* Ball, *ſo as the Degrees that was at the* Horizon *or* Meridian, *will be moved away, and thereby the Poſition of the* Globe *altered: To avoid which inconvenience you may make uſe of a Quill, thruſting the Feather end between the* Ball *and the* Brazen Meridian, *and ſo wedge it up, without wronging the* Globe *at all, till your Propoſition be anſwered.*

## PROB. I.

### *To find the* Longitude *and* Latitude *of* Places *on the* Terreſtrial Globe.

SEek the *Place* on the *Terreſtrial Globe*, whoſe *Longitude* and *Latitude* you would know, and bring the *Place* to the

*Brazen*

*Brazen Meridian*; and see how many Degrees of the *Equator*, is cut by the *Meridian*, from the First general *Meridian* (which on my *Globes* pass through *Gratiosa*, one of the Isles of the *Azores*) for that number of Degrees is the *Longitude* of the *Place*.

*Example.*

I desire to know the *Longitude* of *London*, and close to the name *London* I find a small mark o thus (which small mark is in some *Globes* and *Maps* adorned with the Picture of a Steeple. *&c.*) therefore I do not bring the word *London* to the *Meridian*, but that small mark; for that always represents the Town or City sought for: And keeping the *Globe* steddy in this Position, I examine how many Degrees of the *Equator* are contained between the *Brazen Meridian*, and the first general *Meridian*; which I find to be 27 Deg. 15. min. Therefore I say the *Longitude* of *London* is 27 Deg. 15 min.

*For the* Latitude.

See on the *Brazen Meridian* how many Degrees are contained between the *Equator* and the mark for *London*, which in this Example is $15\frac{1}{2}$; therefore I say *London* hath $15\frac{1}{2}$ *North Latitude*.

## PROB. II.

*The* Longitude *and* Latitude *being known, to Rectifie the* Globe *fit for Use.*

1. WHen you Rectifie the *Globe* to any particular *Longitude*, you must move the *Brazen Meridian* through the notches of the *Horizon*, till the same number of Degrees accounted on the *Meridian* from the *Pole* (about which the *Hour Circle* is) towards the *North* point in the *Horizon* (if in *North* Latitude, and toward the *South* if in *South* Latitude) come just to the edge of the *Horizon*.

*Example.*

By the former Proposition I found the Latitude of *London* to be

be 51½ Degrees *North Latitude*; therefore I count 51½ Degrees from the *Pole* downwards towards my right Hand, and turn the *Meridian* through the Notches of the *Horizon* till those 51½ Degrees come exactly to the uppermost edge of the *North* point in the *Horizon*; and then is the *Meridian* rectified to the *Latitude* of *London*.

2. Next Rectifie the *Quadrant of Altitude*, after this manner. Screw the edge of the *Nut* that is even with the Graduated edge of the thin Plate, to 51½ Degrees of the *Brazen Meridian*, accounted from the *Equinoctial* on the *Southern* side the *Horizon*, which is just the *Zenith* of *London*; and then is your *Quadrant* Rectified.

3. Bring the Degree of the *Ecliptick* the *Sun* is in that Day to the *Meridian*; which you may learn to know by the next Probleme, and then turn the *Index* of the *Hour Circle* to the Hour [illegible]. on the *South* side the *Hour Circle*, and then is your *Hour Circle* also Rectified fit to use for that Day.

4. Lastly, If you will Rectifie the *Globe* to correspond in all respects with the Position and Situation of the *Sphere*; you must set the four Quarters of the *Horizon*, *viz. East*, *West*, *North*, and *South*, agreeable with the four Quarters of the World; which you may do by the *Needle* in the Bottom of the *Horizon*; for you must turn the *Globe* so long till the *Needle* point just to the *Flower-de-Luce*. Next you must set the Plain of the Wooden *Horizon* parallel to the *Horizon* of the *World*; which you may try by setting a common *Level* to the four Quarters of the *Horizon*. And then posting the Degree of the *Ecliptick* the *Sun* is [illegible] to the Heighth above or Depth below the *Horizon* the *Sun* hath in *Heaven* (as by Prob. 11.) your *Globe* is made correspondent in all points with the frame of the *Sphere*, for that particular *Time* and *Latitude*.

## PROB. III.

### *To find the Place of the* Sun *in the* Ecliptick, *the Day of the Month being first known.*

SEek the Day of the Month in the Circle of Months, upon the *Horizon*, and right against it in the Circle of *Signs* is the Degree of the *Ecliptick* the *Sun* is in.

*Example.*

*Example.*

Imagine the Day to be given is *May* 10. therefore I ſeek on the *Horizon* in the Circle of Months, for *May*, and find the Months divided into ſo many parts as there is Days in the Month; which parts are marked with Arithmetical Figures, from the beginning of the Month to the end, and denote the number of the Day of the Month that each Diviſion repreſents; therefore among the Diviſions I ſeek for 10, and directly againſt it in the Circle of *Signs*, I find ♉ 29 Degrees. Therefore I ſay, *May* 10. the *Suns* Place is 29 Degrees of ♉.

But note, That if it be *Leap Year*, inſtead of the 10th of *May*, you muſt take the 11th of *May*, becauſe *February* having in a *Leap-Year* 29 Days, the 29 of *February* muſt be reckoned for the firſt of *March*; and the firſt of *March* for the ſecond of *March*; the ſecond of *March* for the third of *March*, and ſo throughout the Year.

The *Leap-Year* is cauſed by the ſix odd Hours more than 365 Days that are aſſigned to every Common Year; ſo that in Revolution of 4 Years, one Day is gained, which is added to *February*; and therefore *February* hath every fourth or *Leap-year* 29 Days.

## PROB. IV.

*To find the day of the Month, the Place of the* Sun *being given.*

AS in the laſt Probleme it was your Task to find on the *Horizon* the Day of the Month firſt, ſo now you muſt firſt ſeek the *Sign* and *Degree* the *Sun* is in, and againſt it in the Circle of Months you ſhall ſee the Day of the Month; as againſt ♉ you have *May* 10.

## PROB. V.

*The Place of the* Sun *given to find its* Declination.

HAving by the third Probleme found the *Suns* Place on the Plain of the *Horizon*, you muſt ſeek the ſame Degree in the

the *Ecliptick* on the *Globe*; then bring that Degree to the *Brazen Meridian*, and the number of Degrees of the *Brazen Meridian* intercepted between the *Equinoctial* and the Degree just over the Degree of the *Ecliptick* the *Sun* is in; is the *Declination of the Sun* for that Day; and bears its Denomination of *North*, or *South*, according to its Position either on the *North* or *South* side the *Equinoctial*.

*Example.*

By the third Probleme aforesaid, of *May* 10. I find ♉ 29. the *Suns* place; therefore I seek in the *Ecliptick* Line on the *Globe* for ♉ 29, and bring it to the *East* side the *Brazen Meridian*, which is the Graduared side; and over ♉ 29. I find on the *Brazen Meridian* 20 Deg. 5 Min. (numbred from the *Equinoctial*;) and because ♉ is on the *North* side the *Equinoctial*, therefore I say, the *Sun* hath *May* 10 *North Declination* 20 Degrees 5 Min.

## PROB. VI.

*The Place of the Sun given, to find its* Meridian Altitude.

THe *Globe* Rectified, Bring the Degree of the *Sun* to the *Meridian* (or which is all one, the Degree of the *Ecliptick* the *Sun* is in;) and the number of Degrees contained between the *Horizon* and the *Suns* place in the *Meridian*, is the number of Degrees that the *Sun* is Elevated above the *Horizon* at Noon, or (which is all one) the *Meridian Altitude of the Sun*.

*Example.*

To know what *Meridian Altitude* the *Sun* hath here at *London*, *May* 10. I bring the *Suns* place (found by the third Probleme) to the *Meridian*, and count on the *Meridian* the number of Degrees contained between the *Horizon* and the Degree just over the *Suns* place; which in this *Example* I find to be 58 ½. Therefore I say the *Suns Meridian Altitude May* 10. is here at *London* 58 ½ Degrees.

## PROB. VII.

*The* Suns Place *given, to find the* Hour of Sun Rising, *and the Length of the* Night *and* Day.

THe *Globe* and *Hour Index* Rectified, seek the Degree the *Sun* is in on the *Globe*, and bring that Degree to the *Eastern*

Side of the Horizon; and the *Index* of the *Hour-Circle* will point at the Hour of *Sun-Rising*.

*Example.*

To know the Hour of *Sun-Rising* here at *London*, *May* 10. The *Suns* place (as before) is 29 ♉, therefore the *Globe* being Rectified (as before) I seek ♉ 29 Degrees on the *Globe*, and bring that Degree to the *East* side of the *Horizon*; and looking on the *Index* of the *Hour-circle*, I find it point at 4 a Clock, and ½ part of an Hour more towards 5; therefore, I say, *May* 10. the *Sun* Rises here at *London* at ½ (which is 10 Minutes) after 4 a Clock in the Morning.

If you double 4 Hours 10 Minutes it gives you the Length of the Night, 8 Hours 20 Minutes: And if you substract the Length of the Night 8 Hours 20 Minutes from 24 Hours, the Length of Day and Night; it leaves the Length of the Day 15 Hours 40 Minutes.

## PROB. VIII.

*To find the Hour of* Sun Set.

TUrn the place of the *Sun* to the *West* side of the *Horizon* and the *Index* of the *Hour Circle* shews on the *Hour Circle* the Hour of *Sun* Set; which on the 10th of *May* aforesaid, is ½ parts of an Hour after 7 a Clock at Night, *viz.* the *Sun* sets at 48 Minutes past 7 a Clock.

## PROB. IX.

*To find how long it is* Twilight *in the Morning & Evening.*

*Twilight* is that promiscuous and doubtful Light which appears before the Rising of the *Sun* in the Morning, and continues after the Setting of the *Sun* in the Evening: It is made by the extension of the *Suns* Beams into the Vapours of the *Air*; when the *Sun* is less than 18 Deg. below the *Horizon*; for the *Sun* ere it Rises, and after it sets, shoots forth its Beams through the *Air*, and so illuminates the Vapours of the *Air*; which illumination does by degrees enlighten the *Horizon*; and spreads through the *Zenith*, even in the *West* ere the *Sun* Rises; and also continues above the *Horizon* after the *Sun* Sets.

Now though it be *Twilight* when the *Sun* is 18 Degrees below the *Horizon*; yet the Duration of *Twilight* is alterable, both in

respect

respect of *Time* and *Place*, for at such *Time* as the *Sun* is fartheſt distant from any *Place*, the *Twilight* shall be Greater, than when it is nearest. And in respect of *Place*, All Places that have great *Latitude* from the *Equator*, have longer *Twilight* than those that are nearer to the *Equator*; for as Authors say, under the *Equator* there is no *Twilight*; when again in many *Climes* both *Northward* and *Southward*, the Nights are indeed no Nights, but only (as it were) a little over-spread with an obscure Shade; and it is either increased or diminished according to the mutation of *Meteorological* Causes.

Therefore to know the beginning of *Twilight* in the Morning hereat *London*, *May* 10, you must (having the *Globe* rectified) turn the Degree of the *Ecliptick* which is opposite to the Place of the *Sun* (*viz.* ♏ 29) till it be elevated 18 Degrees in the *Quadrant of Altitude* above the *Horizon* in the *West*; so shall 29. Deg. of ♉ be depressed 18 Deg. below the *Horizon* in the East side, and the *Index* of the *Hour Circle* point at the Hour that *Twilight* begins: then substract the Hour and Minute that *Twilight* begins from the Hour and Minute of *Sun* Rising, if in the Morning; or substract the Hour of *Sun* Set from the Hour of *Twilight*, if at Night, and the Remainder is the length of Twilight.

## *Example.*

The *Globe*, *Quadrant*, and *Hour-Index* being Rectified, as before; and the *Suns* place given ♉ 29. I seek the opposite Degree on the *Globe* after this manner: I bring ♉ 29. to the *Meridian*, and observe what Degree of the *Ecliptick* the opposite part of the *Meridian* cuts; and because I find it cuts ♏ 29. therefore I say ♏ 29. is opposite to ♉ 29. having found the opposite Degree, I bring it into the *West*, and also the *Quadrant of Altitude*, and joyn ♏ 29 to 18 Degrees (accounted upwards on the *Quadrant*) so shall ♉ 29 be depressed 18 Degrees in the *East* side the *Horizon*; then looking what Hour the *Hour-Index* points at in the *Hour-Circle*, I find it to be 1 Hour 8 Min. which shews that *Twilight* begins at 8 Minutes past 1 a Clock in the Morning.

And if you substract 1 Hour 8 Minutes, from 4 Hours 11 Minutes, the Time of *Sun* Rising found by the 7th Probleme, it leaves 3 Hours 3 Minutes for the Length of *Twilight*: And if you double 1 Hour 8 Minutes, the Beginning of *Twilight*, it

makes 2 Hours 16 Minutes for the intermission of Time between *Twilight* in the Evening, and *Twilight* in the Morning; So that *May* 10. absolute Night is but 2 Hours 16 Minutes Long, here at *London*.

The Reason why you bring the Degree opposite to the *Suns* place to the *West*, is, because the *Quadrant* containing but 90 Degrees will reach no lower than the *Horizon*, but this Probleme requires it to reach 18 Degrees beneath it; therefore by this Help, you have the Proposition answered, as well as if the *Quadrant* did actually reach 18 Degrees below the *Horizon*. This shift you may have occasion to make in some other Problemes.

If you would know when *Twilight* ends after the *Sun* Sets; you shall find it by bringing the Degree of the *Ecliptick* opposite to the place of the *Sun* to 18 Degrees of the *Quadrant of Altitude*, on the *East* side the *Horizon*; for then shall the *Index* of the *Hour-Circle* point at 10 Hours 52 Minutes; which shews that it continues *Twilight* till 52 Minutes past 10 a Clock at Night, *May* 10. here at *London*.

## PROB. II.

*The* Suns *Place given, to find its* Amplitude; *And also to know upon what* point of the Compass *it* Riseth.

THE *Globe* &c. Rectified: Bring the *Suns* place to the *East* side the *Horizon*; and the number of Degrees intercepted between the *East* point of the *Horizon* and the *Suns* place, is the number of Degrees of *Amplitude* that the *Sun* hath at its Rising; and bears its denomination either of *North* or *South*, according to its inclination to either point in the *Horizon*.

Or if you would know upon what *Point of the Compass* the *Sun* Rises; look but in the Circle of *Winds*, and against the place of the *Sun* you have the name of the *point of the Compass* upon which the *Sun* Riseth.

### *Examples* of both.

*May* 10. the *Suns* place is ☌ 29. Therfore the *Globe* being rectified; I bring ☌ 29. to the *East* side the *Horizon*, and find it touch against 33 Degrees 20 Minutes from the *East* point towards the *North*: Therefore I say the *Sun* hath *North Amplitude* 33 Degrees 20 Minutes.

And

And to know upon what *point of the Compass* the *Sun* Rises; I keep the *Globe* to its Position, and look in the Circle of *Winds*, in the outmost Verge of the *Horizon*, and find the *Suns* place against the *Wind*, named *North East and by East*; therefore I say *May* 10. here at *London*, the *Sun* Riseth upon the *North East and by East point* of the *Compass*.

## PROB. XI.

### *The Day of the Month and Hour of the Day given, to find the* Height of the Sun, *in any given* Latitude.

THe *Globe*, &c. Rectified, turn about the *Globe* till the *Index* of the *Hour-Circle* point (in the *Hour-Circle*) to the Hour of the Day; then bring the *Quadrant of Altitude* to the *Suns* place in the *Ecliptick*, and the Degree on the *Quadrant* which touches the *Suns* place, shall be the number of Degrees of the *Suns Altitude*.

*Example.*

*May* 10. here at *London*; at 53 Minutes past 8 a Clock in the Morning, I would know the Height of the *Sun* above the *Horizon*. Therefore I turn about the *Globe* till the *Index* of the *Hour-Circle* comes to 53 Minutes past 8 a Clock (which is almost 9) in the *Hour-Circle*: And keeping the *Globe* to this position, I bring the *Quadrant of Altitude* to the *Suns* place, *viz.* ♉ 29 (found by the third Probleme;) and because the *Suns* place touches upon 40 Degrees of the *Quadrant*, therefore I say *May* 10. 53 Minutes past 8 a Clock in the Morning, here at *London*, The *Sun* is just 40 Degrees above the *Horizon*; or which is all one, hath 40 Degrees of *Altitude*.

## PROB. XII.

### *The* Altitude *of the* Sun *and Day of the Month given, to find the Hour of the Day.*

AN Hour is the 24th part of a Day and a Night, or the space of Time that 15 Degrees of the *Equator* takes up in passing through the *Meridian*; for the whole *Equator* which contains 360 Degrees, passes through the *Meridian* in 24 Hours, therefore 15 Degrees which is the 24th part of 360 pass through in one Hour. These Hours are vulgarly divided into Halfs, Quarters,

ters and Half quarters; but Mathematically into Minutes, Seconds, Thirds, Fourths, &c. A Minute is the 60 part of an Hour, so that 60 Minutes make an Hour; 30 Half an Hour; 15 a Quarter of an Hour: A Second is the 60 part of a Minute; a Third is the 60 part of a Second: A Fourth is the 60 part of a Third; and so you may run on to Fifths, Sixths, Sevenths, &c. if you please; 12 of these Hours make a Day, and 12 more make a Night; so that Day and Night contain 24 Hours, as aforesaid; which are vulgarly numbred from Noon with 1, 2, 3, to 12, at Night; and then begin again with 1, 2, 3, till 12, at Noon: But by *Astronomers* they are numbred from Noon with 1, 2, 3, &c. till 12 at Night, and so forward to 13, 14, 15, till 24, which is just full Noon the next Day. Yet in this Treatise I shall mention the Hours as they are vulgarly counted, *viz.* from 1 Afternoon till 12 at Night, and call the Hours after Midnight by 1, 2, 3, 4, &c. in the Morning, to 12 at Noon again the next Day. But to the Operation.

The *Globe*, &c. Rectified. Bring the place of the *Sun* to the number of Degrees of *Altitude*, accounted upon the *Quadrant of Altitude*, and the *Hour Index* shall point at the Hour in the *Hour-Circle*; yet herein respect must be had to the Fore or Afternoons *Elevation*; as shall be shewed in the next Probleme.

*Example.*

*May* 10. The *Sun* is elevated 40 Degrees above the *Horizon* here at *London*; therefore having found the place of the *Sun*, by the third Probleme, to be ♉ 29, I move the *Globe* and *Quadrant*, till I can join the 29th Degree of ♉ to the 40th Degree upon the *Quadrant of Altitude*; and then looking on the *Hour-Circle*, I find the *Index* point at 53 Minutes past 8 a Clock, for the Forenoon *Elevation*; and at 3 Hours 7 Minutes for the Afternoons *Elevation*. Therefore if it be Forenoon, I say it is 53 Minutes past 8 a Clock in the Morning. But if it be Afternoon, I say it is 7 Minutes past 3 a Clock in the Afternoon.

## To find the Hour of the Day, if the *Sun* Shines.

This, the Right Honourable the Earl of *Castlemain* has hinted in § 1. *Oper.* 10. of his Book intituled, *The English Globe*: The manner is thus, Rectifie the *Globe* to correspond in all respects with the Situation of the Sphere, as by *Prob.* 2. of this

this Book; ſo ſhall the ſhadow of the *Axis* (between the 10th of *March* and the 13th of *Sept.*) lye upon the Hour of the Day in the *Hour-Circle*. But to find the Hour the other half Year, you muſt, keeping the *Horizon* ſtill in its poſition, turn the *North-Pole* of the *Globe* till it be depreſſed under the *Horizon* on the *South* ſide, ſo many Degrees as before it was Elevated on the *North* ſide; ſo ſhall the *North-Pole* be directly oppoſite to its firſt Poſition, and ſhadow of the *Axis* lie on the Hour of the Day in the *Hour Circle*.

## PROB. XII.

### *How to know whether it be Before or After Noon.*

HAving made one Obſervation, you muſt make a ſecond a little while after the firſt; and if the *Sun* increaſe in *Altitude*, it is before Noon; but if it decreaſe in Altitude, it is after Noon.

*Example.*

The *Sun* was at 8 Hor. 53 Min. *Elevated* 40 Degr. above the *Horizon*; a little while after (ſuppoſe for examples ſake a Quarter of an Hour) *viz.* at 9 Hor. 8. Min. I obſerve again the Height of the *Sun*, and find it 42 Degrees High; ſo that the *Altitude* is increaſed 2 Degrees therefore I ſay, it is Forenoon: But if the *Sun* had decreaſed in *Altitude*, I ſhould have ſaid, it is Afternoon.

### *How to take* Altitudes *by the* Quadrant, Aſtrolabe, *and* Croſs-ſtaff.

There are divers Inſtruments whereby *Altitudes* may be taken; but the moſt in uſe are the *Quadrant*, *Aſtrolabe*, and *Croſs-ſtaff*. A *Quadrant* is an Inſtrument comprehended between two ſtraight lines making a right Angle, and an Arch deſcribed upon the Right Angle, as on the Center, containing 90 Degres, which is a quarter of a Circle; and therefore the Inſtrument is called a *Quadrant*. See this Figure.

A represents the Center, upon which is fastned a Plumb-line, A. B. the one side A. C. the other side, upon which the *Sights* are placed: B. C. the Arch or *Quadrant*, which is divided into 90 equal parts, and numbred from B. to C: D one *Sight* E the other *Sight*: F the *Plumbet* fastned to the *Plumb-line*.

When by this Instrument you would Observe the Height of the *Sun*, you must turn the Center *A* to the *Sun*, and let Beams thereof dart in at the hole in the first *Sight* D, through the hole in the Second *Sight* E; so shall the *Plumb-line* lye upon the Degree in the *Limb* of the *Suns Elevation*: As if the *Plum-line* lie upon the 20th Degree, then shall the Altitude be 20 Degrees; if on 25 the *Altitude* shall be 25 Degrees; and for any number of Degrees the Thred or *Plumb-line* lies on, the same number of Degrees is the *Altitude* of the *Sun*.

But

But if it be a *Star* whose *Altitude* you would Observe; you must hold up the *Quadrant*, and joyn the *Limb* to your Cheek-bone, and turn the Center towards the *Star*; then winking with one Eye, look through the Holes of the *Sights* with the other Eye, till you can see the *Star* through those Holes; so shall the *Plumb-line* (as before in the *Sun*) hang upon the Degree in the *Limb* of the *Stars Elevation*.

Another sort of *Quadrant* is made with a moveable *Index*, as is represented in this Figure.

A is the *Center*, A B and A C the two sides, B C the *Limb*, D E two *Sights* fixed upon a moveable *Index* or *Label*; F G two other *Sights* for Observing the *Horizon*.

When by this *Quadrant* you would observe an *Altitude*, the side B A must parallel to the *Horizon*, and the *Index* must be moved till the Object (be it either the *Sun*, *Moon* or any *Star*) be seen through the Holes or Slits of the *Sights*, placed on the *Index*; for then the *Arch* D B shall be the *Elevation* required. You

may know when the side B A is parallel to the *Horizon*, by Observing the parting of *Heaven* from the *Earth* through the *Sights* of the Side B A.

## *To take* Altitudes *with the* Astrolabe.

The *Astrolabe* is a round Instrument flat on either side, upon one of the flats or plains is described a Circle, as BCDE, divided into 360 equal parts or Degrees, numbered from the Line of Level B A C, with 10, 20, &c. to 90, in the perpendicular D C. Upon the perpendicular is fastned a *Ring*, as F, so as the Instrument hanging by it, the Line of Level may hang parallel to the *Horizon*: Upon the Center is a Moveable *Label* or Ruler, as G H, whereupon is placed two *Sights*, as I K.

If you desire further instructions for making this Instrument, you may peruse Mr. *Wright* in his *Division of the whole Art*

*of*

*of Navigation*, annexed to his *Correction of Errors*; where he also shews the Use of it at large; which in brief is as follows.

You must hold the *Astrolabe* by the Ring in your left hand, and turning your right side to the *Sun*, lift up the *Label* with your right hand, till the Beams of the *Sun* entring through the Hole of the uppermost *Vane* or *Sight*; doth also pierce through the Hole in the nethermost *Vane* or *Sight*; and the Degree and part of Degree that the *Label* lies on is the height of the *Sun* above the *Horizon*.

But if it be a Star you would observe, you must use the *Astrolabe* as you were directed to use the *Quadrant*, holding it up to your Cheek-bone, and looking through the *Sights*, &c.

## *To take* Altitudes *with the* Cross-Staff.

This Instrument consists of a *Staff* about a Yard long, and 3 quarters of an Inch square: Upon it is fitted a *Vane* (or sometime two or three) so as it may slide pretty stiff upon the *Staff*, and stand at any of the divisions it is set to.

The making is taught by Mr. *Wright* aforesaid: But the use is as follows.

You must put that end of the *Cross-staff* which is next 90 Degrees to your Cheek-bone, upon the outer corner of your Eye, and holding it there steddy, you must move the *Vane* till you see the *Horizon* joyned with the lower end thereof, and the *Sun* or *Star* with the higher end; then the Degree and part of Degree which the *Vane* cutteth upon the *Staff*, is the Height of the *Sun* or *Star*.

Some of these ways for taking *Altitudes* have been formerly taught by others that have treated upon the *Use of Globes*; and therefore because some would be apt to think this Treatise uncompleat if I did not shew these ways also, I have thought fit to insert them: Yet the same things may be performed by the *Globe* alone, without troubling your self with multiplicity of Instruments, if your *Globe* be made with a hollow *Axis*; for then if the *Globe* stand *Horizontal*, you shall by Observing the Object through the *Axis*, have the Degree of *Elevation*, noted by the Superficies of the *Horizon*.

## PROB. XIV.

### *To Observe with the* Globe *the* Altitude *of the* Sun.

PLace the *Globe* so that the upper Plain of the *Horizon* may stand parallel to the Plain of the *Horizon* of your Place; as was taught by the Second Probleme; then turn the *North Pole* towards the *Sun*, and place it higher or lower, by moving the *Meridian* through the Notches of the *Horizon*, till the Beams of the *Sun* pierce quite through the *Axis* of the *Globe*: So shall the Arch of the *Meridian* comprehended between the *Pole* and the edge of the *Horizon*, be the number of Degrees that the *Sun* is elevated above the *Horizon*.

### *Example.*

*March* 20. just at Noon, here at *London*, I would Observe the *Meridian Altitude* of the *Sun*. Therefore placing the *Horizon* Horizontal, as by the Second Probleme: I turn the *North Pole*

*Pole* towards the *Sun*, and move it with the *Meridian* upwards or downwards, either to this ſide or that, till I can fit it to ſuch a poſition that the *Sun*-Beams may dart quite through the hollow *Axis* of the *Globe*; which when it does, I look on the *Meridian*, and find 42 Degrees 25 Min. comprehended between the *Pole* and the Superficies of the *Horizon*: Therefore I ſay the *Meridian Altitude* of the *Sun*, *March* 20. here at *London* is 42 Degrees 25 Min.

## PROB. XV.

### *To find the* Elevation *of the* Pole, *by the* Meridian Altitude *of the* Sun, *and Day of the Month given.*

THe Day of the Month is *March* 20. By the 4th Prob. you may find the place of the *Sun* to be ♈ 10. Therefore bring the place of the *Sun* to the *Meridian*, and Elevate it above the *Horizon*, the ſame number of Degrees it hath in Heaven; ſo ſhall the Arch of the *Meridian* comprehended between the *Pole* and the *Horizon*, be the Elevation of the *Pole* in your Place.

### *Otherwiſe.*

The Day of the Month given is *March* 20. ſo that by the 4th Prob. you have the *Suns* place ♈ 10; and by the fifth, the *Declination* of the *Sun* 3, 55. *North*; therefore the *Declination* being *North*, and you on the *North* ſide the *Equator*; you muſt ſubtract 3. 55. from the *Meridian Altitude* 42. 25. and there remains 38. 30. for the Height of the *Equinoctial* above the *Horizon*: But if your *Declination* had been *South*, you muſt have added 3. 55. to the *Meridian Altitude*, and the Sum would have been the Elevation of the *Equinoctial*. Having the Elevation of the *Equinoctial*, you may eaſily have the Elevation of the *Pole*; for the one is always the Complement of the other to 90. Thus the Height of the *Equinoctial* 38. 30. ſubtracted from 90, leaves 51. 30. for the Elevation of the *Pole*, here at *London*. And thus it follows, That the *Latitude* of any place from the *Equinoctial*, is always equal to the Elevation of the

the *Pole*; for between the *Zenith* and the *Equinoctial* is contained the Complement of the Heighth of the *Equinoctial* above the *Horizon* to 90.

## PROB. XVI.

### *To take the* Altitude *of any* Star *above the* Horizon, *by the Globe.*

THe *Horizon* of the *Globe* set parallel to the *Horizon* of the *World*, as before; Turn the *North Pole* towards the *Star*, and when you can see the *Star* through the *Axis*, the *Northern* Notch of the *Horizon* will cut the Degree of *Elevation* on the *Meridian*.

*Example.*

*April* 19. at 11 a Clock at Night, I would Observe the *Altitude* of *Spica Virgo*. Therefore I set the *Horizon* parallel to the *Horizon* of the *World*, as by the Second Probleme, and turn the *Northern Pole* till it point towards the *Star*: Then looking in at the *South Pole* of the *Globe* through the *Axis*, I shall see the *Star*, and have on the *Meridian* the Question resolved. But if it point not exactly, then I move the *North Pole* either upwards or downwards to the right or to the left Hand, according as I may find occasion, till I can see the *Star* through the *Axis*; and then the edge of the Notch in the *Horizon* cuts 28 Degrees 59 Min. on the *Brazen Meridian*. Therefore I say *April* 19. at 11 a Clock at Night, here at *London*, the *Altitude* of *Spica* ♍ is 28 Degr. 59 Min. above the *Horizon*.

## PROB. XVII.

### *By the* Meridian Altitude *of any* Star *given, to find the Heighth of the* Pole.

JOyn the *Star* to the *Meridian*, and place it to the *Altitude* Observed; so shall the number of Degrees intercepted between the *Pole* and the *Horizon*, be the Elevation of the *Pole*.

*Example.*

*Example.*

*Spica Virgo* is observed to have 28 Degr. 59 Min. *Meridian Altitude*; therefore I bring *Spica Virgo* to the *Meridian*, and Raise it or Depress it higher or lower as I find occasion, till it is just 28 Degr. 59 Min. above the *Horizon*: Then I count number of Degrees between the *Pole* and the *Horizon*, and find them 51½. Therefore I say the Elevation of the *Pole* is here at *London* 51½. Yet note, If the *Star*, whose *Altitude* you Observe, have fewer number of Degrees of *Declination* from the *Pole* than the Elevation of the *Pole*, you may be apt to mistake in its coming to the *Meridian*; for those *Stars* never set; and therefore are twice visible in the *Meridian* in 24 Hours; once above the *Pole*, and once under the *Pole*.

If your *Star* have greater *Altitude* than the *North Star*, it is Above the *Pole*: but if it have less, it is below the *Pole*; so that if you know but whether it be Above or Below, it is enough; for so you may accordingly Raise it to the *Altitude* on the *Meridian* it hath *Heaven*, and joyn it to the *Meridian* either Above or Beneath the *Pole*, as the *Star* is placed in *Heaven*: and then the Arch of the *Meridian* comprehended between the *Pole* and the *Horizon*, is the *Elevation* of the *Pole*, as aforesaid.

*Otherwise.*

Having the *Meridian Altitude* of the *Star*, you must find its *Declination* by the 27 Probleme; and if the *Declination* be *South*, and you on the *North* side the *Equator*, you must add the *Declination* to the *Meridian Altitude*, and the Sum of both makes the *Altitude* of the *Equinoctial*: But if the *Declination* be *North*, and you on the *North* side the *Equator*, you must Subtract the *Declination* from the *Meridian Altitude*, (as was taught by the 15 Prob. in the *Example* of the *Sun*) and the Remainder is the *Altitude* of the *Equinoctiul*. Then (as was taught by the 15 Prob. aforesaid) Subtract the *Altitude* of the *Equinoctial* from 90. The Remainder is the *Elevation* of the *Pole* in your Place.

*Example*

*Example.*

By the last Probleme the *Meridian Altitude* of *Spica Virgo* was 28 Degrees 5 Minutes and the *Declination* of *Spica* by the 27th Probleme is found 9 Degrees 3 Min. *South*: Therefore because the *Declination* is *South*, I add 9 Degrees 3 Min. to the *Meridian Altitude*, which makes 38 Degrees 30 Min. for the *Elevation* of the *Equinoctial*; which 38 Degrees 30Min. Subtracted from 90, leaves 51 Deg. 30 Min. for the *Elevation* of the *Pole* here at *London*.

## PROB. XVIII.

*Another way to find the Height of the* Pole *by the* Globe; *if the place of the* Sun *be given: And also to find the Hour of the Day and* Azimuth, *and* Almicanter *of the* Sun.

THis must be performed by help of a *Spherick Gnomon*; which is a small *Pin* or *Needle* fixed perpendicularly into a small *Basis* with an Hollow concave Bottom, that it may stand upon the convexity of the *Globe*. Therefore the *Horizon* of the *Globe* being set parallel to the *Horizon* of the *World* (as by the second Probleme) the *Spherick Gnomon* must be set exactly upon the place of the *Sun*; and then turning the *Globe* about (upon its *Axis* either from *East* to *West*, or contrarily from *West* to *East*; or else by the *Meridian* through the Notches of the *Horizon*) till the *Spherick Gnomon* cast no Shadow on any side thereof, you have on the *Meridian* in the *North* point of the *Horizon* the number of Degrees that the *Pole* is elevated above the *Horizon*.

*Example.*

Imagine the four Quarters of the *Horizon* of the *Globe* correspond with the four Quarters of the *Horizon* of the *World*; and the plain of the *Horizon* of the *Globe* is parallel to the plain of the *Horizon* of the *World*: The *Suns* place is ♉ 29, which

which I find on the *Globe*, and place the *Spherick Gnomen* thereon; then at a gueſs I move the *Globe* both on its *Axis*, and by the *Meridian* (as near as I can) ſo as the *Spherick Gnomen* may caſt no Shadow; yet if it do, and the Shadow fall towards the *North Pole*; then I Elevate the *North Pole* more till the Shadow falls juſt in the middle of its ſelf; but if the Shadow fall downwards towards the *South Pole*, then I Depreſs the *North Pole:* If the Shadow fall on the *Eaſt* ſide, I turn the *Globe* on its *Axis* more to the *Weſt*; and if the Shadow fall to the *Weſt*, I turn the *Globe* more into the *Eaſt*; and the Degree of the *Meridian* which the *North* Point of the *Horizon* touches, is the Degree of the *Poles* Elevation: which in this Example is 51½ the *Latitude* of the City of *London*.

By this Operation you have alſo given the Hour of the Day in the Hour-Circle, if you keep the *Globe* unmoved; and the *Azimuth*, and *Almicantar*, if you apply but the *Quadrant of Altitude* to the place of the *Sun*, as by the 22 and 23 Problemes.

## PROB. XIX.

### *To Obſerve by the* Globe *the Diſtance of two* Stars.

YOu muſt pitch upon two *Stars* in the *Meridian*, and Obſerve the *Altitude* of one of them firſt, and afterwards the Altitude of the other; then Subtract the Leſſer *Altitude* from the Greater, and the Remainder ſhall be the Diſtance required.

### *Example.*

*March* 7. at 11 a Clock at Night here at *London*, I ſee in the *Meridian* the two *Stars* in the Foremoſt *Wheels* of the *Waggon*, in the *Conſtellation* of the *Great Bear*, called by the Sea-men *Pointers*, (becauſe, they always point towards the *Pole-ſtar*) Therefore to Obſerve the Diſtance between theſe two *Stars*, I firſt Obſerve (as by the laſt Probleme) the *Altitude* of the moſt *Northern* to be 77 Degrees 59 Minutes, and ſet down that Number of Degrees and Minutes with a Pen and Ink on a Paper, or with a piece of Chalk, or a Pencil, on a Board; and afterwards I Obſerve the *Altitude* of the other *Star* which is un-

der it, as I did the firſt, to be 83 Degrees 21 Min. and ſet that number of Degrees and Minutes alſo down, under the other number of Degrees and Minutes: Then by Subtracting the Leſſer from the greater, I find the Remainder to be 5 Degrees 22 Min. which is the Diſtance of the two *Stars* in the *Great Bear*, called the *Pointers*.

## PROB. XX.

*How you may learn to give a Gueſs at the number of Degrees that any two* Stars *are diſtant from one another; or the number of Degrees of* Altitude *the* Sun, *or any* Star, *is Elevated above the* Horizon; *only by looking up to* Heaven *without any Inſtrument.*

BEtween the *Zenith* and *Horizon* is comprehended an Arch of a Circle containing 90 Degrees; ſo that if you ſee any *Star* in or near the *Zenith*, you may know that *Star* is 90, or near 90 Degrees High; and by ſo much as you may conceive it wants of the *Zenith*, ſo much you may gueſs it wants of 90 Degrees above the *Horizon*. But this Rule you may Gueſs at an Arch of *Heaven* containing 90 Degrees, or at an Arch of *Heaven* containing 45 Degrees if by your Imagination you divide the whole Arch into two equal parts, for then ſhall each of them contain 45 Degrees; And if by your Imagination you divide the whole Arch of 90 into 3 equal parts, each Diviſion ſhall contain an Arch of 90 Degrees, &c. But this way is a little too rude for Gueſſing at Stars Elevated but few Degrees, or for *Stars*, Diſtant but few Degrees from one another. Therefore that you may learn to gueſs more preciſely at Diſtances in *Heaven*, you may either with a *Quadrant*, *Aſtrolabe*, or the *Globe*, find the exact Diſtance of any two known *Stars* that are but few Degrees aſunder, and by a little revolving the Diſtance of thoſe *Stars* in your fancy, you may at length ſo imprint their Diſtance in your Memory, that you may readily gueſs the Diſtance of other *Stars* by the Diſtance of them.

*Example.*

You may find either by the *Globe*, *Quadrant*, or *Aſtrolabe* (for

(for they all agree) 3 Degrees comprehended between the firſt *Star* in *Orion's Girdle*, and the Laſt; therefore by a little conſidering that Diſtance, you may imprint it in your Fancy for 3 Degrees, and ſo make it applicable to other *Stars*, either of the ſame Diſtance or more, or leſs: And the *Pointers* (by the laſt Probleme) are Diſtant from one another 5 Degrees, and almoſt an half: Theſe are always above our *Horizon*, and therefore may always ſtand as a Scale for 5 and a half Degrees; ſo that by theſe for 5½ Degrees, and thoſe in *Orions Girdle* for three Degrees, and others Obſerved, either of Greater or Leſſer diſtance, you may according to your own Judgment ſhape a Gueſs, if not exactly, yet pretty near Truth, when you come to other *Stars*. Thus you may exerciſe your Fancy upon *Stars* found to be 10 or 15 Degrees aſunder, or more or leſs; and with a few Experiments of this Nature enure your Judgment to Gueſs at Diſtances, and enable your Memory to retain thoſe Gueſſes.

This way of Gueſſing will be exact enough for finding the Hour of the Night by the *Stars*, for moſt common Uſes; or the Hour of the Day, by Gueſſing at the *Altitude* of the *Sun*; if after you have Gueſſed at the *Altitude*, you work as was taught by Prob. 12. for the Hour of the Day; and as ſhall be taught in the next Problem for the Hour of the Night.

## PROB. XXI.

*The Day of the Month and* Altitude *of any* Star *given; to find the Hour of the Night.*

THe *Globe*, *Quadrant*, and *Hour-Index* Rectified; bring the *Star* on the *Globe* to the ſame number of Degrees on the *Quadrant of Altitude* that it hath in *Heaven*: So ſhall the *Index* of the *Hour-Circle* point in the *Hour-Circle* at the Hour of the Night,

*Example.*

*March* 10. The *Altitude* of *Arcturus* is 35 Degrees above the *Horizon* here at *London*: Therefore having the *Globe*,

*Quadrant*, and *Hour- Index* Rectified, I bring *Arcturus* on the *Globe* to 35 Degrees on the *Quadrant of Altitude*: and then looking in the *Hour-Circle*, I find the *Index* point at 10 a Clock, which is the Hour of the Night.

## PROB. XXII.

*The place of the* Sun, *and Hour of the Day given; to find its* Azimuth *in any assigned* Latitude.

THe *Globe*, &c. Rectified to your *Latitude*; Turn the *Globe* till the *Index* of the *Hour-Circle* come to the Given Hour; and bring the *Quadrant of Altitude* to the place of the *Sun*; so shall the number of Degrees contained between the *East* or *West* point of the *Horizon*, and the Degree cut by the *Quadrant of Altitude* on the *Horizon*, be the number of Degrees of the *Suns Azimuth*, at that Time.

*Example.*

*May* 10. at 53 Minutes past 8 a Clock in the Morning, I would know the *Azimuth* of the *Sun*: Therefore (the *Globe* being first Rectified) I turn about the *Globe* till the *Index* of the *Hour-Circle* point to 53 Minutes past 8 a Clock, or which is all one, within Half a quarter of an Hour of 9; then I move the *Quadrant of Altitude*, to the Degree the *Sun* is in that Day, and there let it remain, till I see how many Degrees is contained between the *East* point, and the *Quadrant of Altitude*, which in this *Example* is 28 Deg. 25 Min. for the *Azimuthal* distance of the *Sun* from the *East* point towards the *North*.

PROB.

## PROB. XXIII.

*The place of the* Sun *and Hour of the Day given, to find the* Almicantar *of the* Sun.

THe finding the *Almicantar* of the *Sun* is upon the matter the ſame with the *Altitude* of the *Sun*; only with this diſtinction, The *Almicantars* are Circles parallel to the *Horizon* deſcribed by the Degree of the *Quadrant of Altitude* upon the *Zenith* as its Center, by turning the *Quadrant* round about the *Globe* till it come again to its firſt place: But the *Altitude* is an Arch of the *Quadrant of Altitude* or *Vertical Circle*, comprehended between the *Horizon* and any point of the *Globe* aſſigned. Their Agreement conſiſts in this; When the *Sun* or any *Star* hath any known *Almicantar*, they are ſaid to have the ſame number of Degrees of *Altitude*; as if the *Sun* be in the 20 *Almicantar*, he hath 20 Degrees of *Altitude*; if in the 30th *Almicantar*, he hath 30 Degrees of *Altitude*, &c. Now becauſe the Operation is the ſame for finding the *Altitude* and *Almicantar*, I ſhall refer you to the 11 Probleme; which ſhews you how to find the *Altitude* or *Height*; and by conſequence the *Almicantar*.

## PROB. XXIV.

*The place of the* Sun *given, to find what Hour it comes to the* Eaſt *or* Weſt; *and what* Almicantar *it then ſhall have.*

THe *Globe*, *Quadrant*, and *Hour-Index* Rectified: Bring the *Quadrant of Altitude* to the *Eaſt* point in the *Horizon*, if you would know what Hour it comes to the *Eaſt*, or to the *Weſt* point, if you would know what Hour it comes to the *Weſt*: Then turn about the *Globe* till the place of the *Sun* come to the *Quadrant of Altitude*; and the *Index* of the *Hour-Circle* ſhall point at the Hour of the Day; which on the Day aforeſaid will be 7 Hor. 7. Min. in the Morning that the *Sun* cometh to the *Eaſt*, and 4 Hor. 53 Min. after Noon that the *Sun* cometh to the *Weſt*. And if you then count the number of Degrees from the

the *Horizon* upwards on the *Quadrant of Altitude*, it will ſhew you the *Almicantar* of the *Sun* for that Time; which will both Morning and Evening be 25 Deg. 30 Min. as was taught by the laſt Probleme.

## PROB. XXV.

*To know at any time what a Clock it is in any other Part of the Earth.*

THe difference of *Time* is reckoned by the acceſs and progreſs of the *Sun*; for the *Sun* gradually circumvolving the *Earth* in 24 Hours, doth by reaſon of the *Earths* rotundity enlighten but Half of it at the ſame moment of *Time*; as ſhall be ſhewed hereafter; ſo that hereby it comes to paſs, that when with us here in *England* it is 6 a Clock in the Morning, with thoſe that have 90 Degrees of *Longitude* to the *Weſtward* of Us, it is yet Midnight; with thoſe that have 180 Degrees of *Longitude* from Us, it is Evening; and with thoſe that have 90 Degrees of *Longitude* to the *Eaſtwards*, it is Noon. So that thoſe to the *Eaſtward* have their Day begin ſooner than Ours: But to the *Weſtward* their day begins after Ours. Therefore that you may know what Hour it is in any Place of the *Earth*, of what Diſtance ſoever it be, you muſt firſt bring the Place of your own Habitation to the *Meridian*, and the *Index* of the *Hour Circle* to 12 on the *Hour-Circle*; Then bring the other Place to the *Meridian*, and the Arch of the *Hour-Circle* comprehended between the Hour 12 and the *Index*, is the difference in *Time* between the two Places.

*Example.*

*London* in *England*, and *Surate* in the *Eaſt-Indies*: Firſt I bring *London* to the *Meridian*, and turn the *Index* of the *Hour-Circle* to 12; then I turn the *Globe Weſtward*, becauſe *London* is *Weſtward* of *Surat*, till *Surat* come to the *Meridian*; and ſee at what Hour the *Index* of the *Hour-Circle* points, which in this *Example* is 5 Hor. 54 Minutes: And becauſe *Surat* lies to the *Eaſtwards* of Us ſo many Degrees, therefore, as was ſaid before, their

their Day begins ſo much before Ours: So that when here at *London* it is 6 a Clock in the Morning, at *Surat* it will be 11. a Clock 54 Minutes; when with Us it is 12 a Clock, with them it will be 5 a Clock 54 Minutes after Noon.

If you would know the difference of *Time* between *London* and *Jamaica*,; Working as before, you may find 5 Hor. 15 Min. but *Jamaica*, is to the *Weſt* of *London*; therefore Their Day begins 5 Hor. 15 Min. after Ours; ſo that when with Us it is Noon, with Them it will be but Three quarters of an Hour paſt 6 a Clock in the Morning; and when with them it is Noon, with Us it will be One quarter paſt 5 a Clock after Noon, &c.

Or you may yet otherwiſe know the difference of *Time*, if you divide the number of Degrees of the *Equinoctial* that paſs through the *Meridian* while the *Globe* is moved from the Firſt place to the Second, by 15. ſo ſhall the Product give you the difference of Hours and Minutes between the two Places; as you will find, if you Try either of theſe Examples, or any other.

## PROB. XXVI.

### *To find the* Right Aſcenſion *of the* Sun, *or* Stars.

THe *Right Aſcenſion* of any point on the *Globe* is found by bringing the point propoſed to the *Meridian*, and counting in the *Equinoctial* the number of Degrees comprehended between the *Vernal Colour* and the Meridian.

### *Example*, for the *Sun*.

*June* 1. I would know the *Right Aſcenſion* of the *Sun*: His place (found as by the third *Probleme*) is *Gemini* 20. Therefore I bring *Gemini* 20 to the *Meridian*; and then the *Meridian* cuts the *Equinoctial* in 79 Deg. 15 Min. accounted from the *Vernal* point *Aries*: Therefore I ſay the *Right Aſcenſion* of the *Sun June* 1. is 79 Deg. 15 Min.

### *Example*, for a *Star*.

I take *Capella*, alias *Hircus*, the *Goat* on *Auriga*'s Shoulder, and

and bring it to the *Meridian*; and find the *Meridian* cut the *Equinoctial* (counting as before from the *Vernal* point ♈) in 73 Degrees 58 Minutes: Therefore I say the *Right Ascention* of *Hircus* is 73 Degrees 58 Minutes. Do the like for any other point of the *Globe* proposed.

## PROB. XXVII.

### *To find the* Declination *of the* Sun *and* Stars.

THe *Declination* of any point on the *Globe* is found by bringing the point proposed to the *Meridian*, and counting the number of Degrees comprehended on the *Meridian* between the *Equinoctial* and the point proposed; and bears its Denomination of *North* or *South*, according as it is Situate on the *North* or *South* side the *Equinoctial*.

### *Example*, for the *Sun*.

*June* 1. I would know the *Declination* of the *Sun*. His place found as before, is *Gemini* 20. Therefore I bring ♊ 20, to the *Meridian*, and find 23 Degrees 8 Minutes comprehended on the *Meridian* between the *Equinoctial* and ♊ 20. and because *Gemini* is on the *North* side the *Equinoctial*; therefore I say *June* 1. the *Sun* hath *North Declination* 23 Degrees 8 Minutes.

### *Example*, for a *Star*.

I take *Hircus* aforesaid, and bring it to the *Meridian*, and find 45 Degrees 40 Minutes comprehended on the *Meridian* between the *Equinoctial* and the *Star Hircus*. And because *Hircus* is on the *North* side the *Equinoctial*; Therefore I say, *Hircus* hath *North Declination* 45 Degrees 40 Minutes. Do the like for any other point on the *Globe* proposed.

But note: The *Right Ascention* and Declination of the *Sun* alters Daily; for in 12 Months he runs through every Degree of *Right Ascention*, and in three Months to his greatest *Declination*: But the *Right Ascention* and *Declination* of the *Stars* is scarce perceivable for some Years: Yet have they also an alteration of *Right Ascention* and *Declination*: For, those *Stars* that

that have but few Degrees of *Right Ascension*, will in process of *Time* have many, and those *Stars* between the *Tropick* and *Equinoctial* that have *North Declination* will in length of *Time* have *South Declination*; and the contrary, (as shall be more fully shewed hereafter:) For, the *Stars* moving upon the *Poles* of the *Ecliptick*, go forwards in *Longitude* one whole Degree in 70½ Years (as hath been shewed before *Book* 1 *Chap.* 3. *Sect.* 3.) and so alter both their *Right Ascention* and *Declination*; as may be seen by this following Table of *Right Ascentions* and *Declinations* of 100 of the most eminent fixed *Stars*; Calculated by *Tycho Brahe*, for the Years 1600 and 1700, which I have inserted; partly, because by it you may see the Difference of their *Right Ascensions* and *Declinations* in 70½ Years; and partly to accommodate those that may have occasion to know their *Right Ascensions* and *Declinations* nearer than the *Globe* can shew them.

## A Table of the *Right Ascensions* and *Declinations* of 100 Select Fixed *Stars*; Calculated by *Tycho Brahe*, for the Years 1600 and 1700. As also their Difference of *Right Ascensions* and *Declinations* in 70 Years.

| Names of the Stars. | 1600. R. Asc. | | Declin. | | | Differentia. R. A. | | Decl. | | 1670. R. Asc. | | Declin. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Scedir, in Cassiopeæ. | 4 | 36 | 54 | 21 | N | 1 | 22 | 34 | S | 5 | 58 | 54 | 55 |
| The Pole Star. (tail. | 5 | 47 | 87 | 9⅓ | N | 3 | 59 | 34 | S | 9 | 46 | 87 | 43½ |
| Southern in the Whales | 5 | 51 | 20 | 12 | S | 1 | 17 | 34 | N | 7 | 8 | 19 | 38 |
| Cassiopeæ's Belly. | 8 | 21 | 58 | 33 | N | 1 | 27 | 34 | S | 9 | 48 | 59 | 7 |
| Girdle Andromeda. | 11 | 50 | 33 | 3 | [illegible] | 1 | 23 | 33 | S | 13 | 13 | 34 | 5 |
| Knee of Cassiopeæ. | 15 | 3 | 58 | 7 | N | 1 | 35 | 33 | S | 16 | 38 | 58 | 40 |
| 1. in ♈ Horn. | 22 | 56 | 17 | 19 | N | 1 | 23 | 33 | S | 24 | 19 | 17 | 50 |
| ♈ Whales Belly. | 22 | 59 | 12 | 16 | S | 1 | 15 | 31 | N | 24 | 14 | 11 | 45 |
| 2. in ♈ Horn. | 23 | 10 | 18 | 50 | N | 1 | 22 | 31 | S | 24 | 32 | 19 | 01 |
| South Foot of Andromeda. | 24 | 55 | 40 | 23 | N | 1 | 29 | 30 | S | 26 | 24 | 40 | 52 |

| Names of the Stars. | 1600. R. Asc. | Decl. | | Precession. R. A. | Decl. | | 1700. R. Asc. | Declin. | |
|---|---|---|---|---|---|---|---|---|---|
| In the Knot in the Line ♑. | 25 22 | 0 50 | N | 1 16 | 30 | S | 26 40 | 1 20 | |
| * Star in V Head. | 26 23 | 21 33 | N | 1 25 | 30 | S | 27 38 | 22 3 | |
| * In the VWhales Jaw. | 40 25 | 3 29 | N | 1 15 | 25 | S | 41 40 | 3 54 | |
| Caput Medusæ. | 40 38 | 39 22 | N | 1 37 | 25 | S | 42 15 | 39 47 | |
| * In Perseus Side. | 44 2 | 48 22 | N | 1 28 | 21 | S | 45 30 | 48 43 | |
| * In the Pleiades. | 50 27 | 22 49 | N | 1 29 | 21 | S | 52 26 | 23 10 | |
| In the Nostrils of ♉. | 59 16 | 14 37 | N | 1 25 | 17 | S | 60 41 | 14 54 | |
| North Eye of ♉ | 61 21 | 18 14 | N | 1 24 | 17 | S | 62 45 | 18 31 | |
| Aldebaran. | 63 26½ | 15 38 | N | 1 26½ | 15 | S | 64 43 | 15 53 | |
| Hircus, Capella. | 71 49 | 45 30 | N | 1 29 | 10 | S | 73 38 | 45 40 | |
| * Orions Foot, Rigel. | 73 51 | 8 43 | S | 1 15½ | 9½ | S | 75 7 | 8 33½ | |
| North Horn ♉. | 75 16 | 28 12 | N | 1 37 | 8 | S | 76 53 | 28 20 | |
| Orions left Shoulder. | 75 58 | 6 55 | N | 1 19 | 8 | S | 77 17 | 6 3 | |
| Belly of the Hare. | 77 48 | 21 6 | S | 1 5 | 7 | N | 78 53 | 20 59 | |
| 1. In Orions Girdle. | 77 58 | 0 39 | S | 1 17 | 7 | N | 79 15 | 0 32 | |
| Uppermost in Orions Face. | 78 21 | 2 36 | N | 1 22 | 7 | S | 79 41 | 0 43 | |
| South Horn ♉. | 78 26 | 20 51 | N | 1 31 | 7 | S | 79 57 | 20 58 | |
| 2. In Orions Girdle. | 79 1 | 1 30 | S | 1 17 | 6 | N | 80 18 | 1 24 | |
| Last in Orions Girdle. | 80 10 | 2 12 | S | 1 16 | 5 | N | 81 26 | 2 7 | |
| Auriga's right Shoulder. | 82 40 | 44 50 | N | 1 55 | 4 | S | 84 35 | 44 54 | |
| Orion's right Shoulder. | 83 26 | 7 16 | N | 1 22 | 4 | S | 84 48 | 7 26 | |
| * Foot ♊. | 93 38 | 16 40 | N | 1 28 | 2 | N | 95 6 | 16 38 | |
| Great Dog, Sirius. (Twin. | 96 53 | 16 11 | S | 1 7 | 4 | S | 98 0 | 16 15 | |
| Head of Castor, the first. | 107 9 | 32 41 | N | 1 44 | 11 | N | 108 53 | 32 30 | |
| The little Dog, Procyon. | 109 37 | 5 12 | N | 1 20 | 12 | N | 110 57 | 6 0 | |
| Head Pollux, second Twin. | 110 13 | 28 55 | N | 1 34 | 12 | N | 111 [illegible] | 28 43 | |
| * In the Stern of the Ship | 117 39 | 23 11 | S | 1 4 | 15 | S | 118 43 | 23 26 | |
| Præsepe ♋. | 124 20 | 21 2 | N | 1 28 | 19 | N | 125 48 | 20 43 | |
| Northern Ass ♋. | 124 58 | 22 51 | N | 1 30 | 20 | N | 126 28 | 22 31 | |
| Southern Ass ♋. | 125 [illegible] | 19 35 | N | 1 27 | 20 | N | 126 54 | 19 15 | |
| The Heart of Hydra. | 137 [illegible] | 57 | S | 1 15 | 25 | S | 138 16 | 7 22 | |
| South of 3. in Neck ♌. | 146 22 | 18 42 | N | 1 28 | 28 | N | 147 50 | 18 14 | |
| Lyons Heart, Basiliscus. | 146 45½ | 13 53½ | N | 1 53½ | 28½ | N | 148 8 | 13 25 | |
| North of 3. in Neck ♌. | 148 33 | 25 23 | N | 1 23 | 29 | N | 150 1 | 24 54 | |
| Middle of 3. in Neck ♌. | 149 25½ | 21 50 | N | 1 50 | 29 | N | 150 51 | 21 21 | |

Names

| Names of the Stars. | 1600. R. | Asc. | Declin. | | Differentia R. A. | Asc. | Decl. | | 1670. R. | Asc. | Declin. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| First lowest in ☐ Ursa Maj. | 159 | 12 | 58 | 31 N | 1 | 37 | 32 | N | 160 | 49 | 57 | 59 N |
| First upper in ☐ Dubhe. | 159 | 37 | 63 | 54 N | 1 | 41 | 32 | N | 161 | 18 | 63 | 22 N |
| * Back ♌. | 163 | 10 | 22 | 43 N | 1 | 27 | 34 | N | 164 | 37 | 22 | 9 N |
| Lions Tail. (Major. | 172 | 9 | 16 | 49 N | 1 | 19 | 34 | N | 173 | 28 | 16 | 15 N |
| Following lowest in ☐ Ursa | 173 | 3 | 55 | 57 N | 1 | 23 | 34 | N | 174 | 26 | 55 | 23 N |
| Uppermost following in ☐. | 178 | 50 | 59 | 15 N | 1 | 20 | 34 | N | 180 | 10 | 58 | 41 N |
| Girdle ♍. | 188 | 53 | 5 | 37 N | 1 | 18 | 34 | N | 190 | 11 | 5 | 3 N |
| Rump Ursa Major, Alioth. | 189 | 1 | 58 | 10 N | 1 | 19 | 33 | N | 190 | 10 | 57 | 37 N |
| Vindemiatrix, ♍. | 190 | 36 | 13 | 8 N | 1 | 17 | 33 | N | 191 | 53 | 12 | 35 N |
| Spica ♍. | 196 | 49 | 9 | 1 S | 1 19½ | | 32½ | S | 197 | 23½ | 9 | 31 S |
| Middle Tail Ursa Major. | 196 | 54 | 57 | 3 N | 1 | 3 | 32 | N | 197 | 57 | 56 | 31 N |
| End Tail Ursa Major. | 202 | 54 | 1 | 22 N | 1 | 2 | 31 | N | 203 | 56 | 50 | 51 N |
| Arcturus. | 209 | 23½ | 18 | 18½ N | 1 | 11 | 29½ | N | 210 | 34½ | 20 | 49 N |
| Left Shoulder of Bootes. | 214 | 2 | 40 | 3 N | 1 | 2 | 27 | N | 215 | 4 | 39 | 36 N |
| South Scale ♎. | 217 | 14½ | 14 | 18 S | 1 | 23 | 27 | S | 218 | 37½ | 14 | 45 S |
| North Scale ♎. | 223 | 54½ | 7 | 50 S | 1 21½ | | 24 | S | 225 | 16 | 6 | 14 S |
| * Northern Crown. | 229 | 26 | 28 | 6 N | 1 | 5 | 21 | N | 230 | 31 | 27 | 45 N |
| * Serpents Neck. | 231 | 12 | 7 | 46 N | 1 | 15 | 21 | N | 232 | 27 | 7 | 25 N |
| North. of 3 * in Front ♏. | 235 | 34 | 18 | 38 S | 1 | 28 | 19 | S | 237 | 2 | 18 | 57 S |
| Left Hand Ophiucus. | 238 | 25 | 2 | 37 S | 1 | 23 | 18 | S | 239 | 48 | 2 | 55 S |
| Heart ♏, Antares. | 241 | 18 | 25 | 26 S | 1 | 32 | 16 | S | 242 | 50 | 25 | 42 S |
| Right Shoulder Hercules. | 243 | 15 | 22 | 27 N | 1 | 5 | 15 | N | 244 | 20 | 22 | 12 N |
| Left Knee of Ophiucus. | 243 | 49 | 9 | 39 S | 1 | 23 | 15 | S | 245 | 12 | 9 | 54 S |
| Right Knee of Ophiucus. | 251 | 50 | 15 | 7 S | 0 | 50 | 10 | S | 252 | 40 | 15 | 17 S |
| Head of Hercules. | 254 | 6 | 14 | 55 N | 1 | 8 | 8 | N | 255 | 14 | 14 | 47 N |
| Left Shoulder of Hercul. | 254 | 40 | 25 | 22 N | 0 | 52 | 8 | N | 255 | 32 | 25 | 14 N |
| Head of Ophiucus. | 259 | 5 | 12 | 56 N | 1 | 11 | 7 | N | 260 | 16 | 12 | 49 N |
| Right Shoulder Ophiucus | 260 | 56 | 4 | 49 N | 1 | 13 | 5 | N | 262 | 9 | 4 | 44 N |
| * Head of the Dragon. | 266 | 52 | 51 | 37 N | 0 | 35 | 2 | N | 267 | 27 | 51 | 35 N |
| * Lyræ. | 275 | 52 | 38 | 28 N | 0 | 50 | 4 | S | 276 | 42 | 38 | 32 N |
| Most Eastern in Head ♐. | 281 | 32 | 21 | 39 N | 1 | 31 | 8 | N | 283 | 3 | 21 | 27 N |
| Vultures Tail. | 281 | 47 | 13 | 20 S | 1 | 13 | 8 | S | 283 | 0 | 13 | 28 S |
| In the Swans Beak. | 288 | 40 | 27 | 10 N | 1 | 1 | 11 | S | 289 | 41 | 27 | 21 N |
| * in Vulture. | 292 | 49 | 7 | 54 N | 1 | 17 | 13 | S | 294 | 0 | 6 | 7 S |
| In the Swans North Wing. | 293 | 10 | 44 | 12 N | 0 | 48 | 14 | N | 293 | 58 | 44 | 26 N |

| Names of the Stars. | 1600. R. Asc. | Declin. | | Differentia. R. A. | Decl. | | 1670. R. Asc. | Declin. |
|---|---|---|---|---|---|---|---|---|
| Upper Horn ♈. | 289 57 | 13 40 | S | 1 25 | 16 N | | 300 22 | 13 24 |
| Lower Horn ♈. | 299 39 | 15 57 | S | 1 27 | 17 N | | 301 6 | 15 40 |
| In the Swans Breast. | 302 1½ | 39 1 | N | 0 53½ | 18 S | | 302 55 | 39 19 |
| Left Hand of ♎. | 306 32 | 10 53 | S | 1 16 | 19 N | | 307 48 | 10 34 |
| Swans Tail. | 306 57½ | 35 3½ | N | 0 51½ | 20½ S | | 307 49 | 44 14 |
| In the Swans South Wing. | 307 31 | 32 30 | N | 1 0 | 21 S | | 308 31 | 32 51 |
| Left Shoulder ♒. | 317 37 | 7 15 | S | 1 21 | 26 N | | 318 58 | 6 49 |
| 1. In Tail ♈. | 319 28 | 18 21 | S | 1 26 | 26 N | | 320 54 | 17 55 |
| In Cepheus Girdle. | 320 46 | 68 50 | N | 0 22 | 26 S | | 321 8 | 69 16 |
| In Pegasus Mouth. | 321 10 | 8 5 | N | 1 18 | 26 S | | 322 28 | 8 31 |
| 2. In Tail ♈. | 321 16 | 17 51 | S | 1 25 | 27 N | | 322 41 | 17 24 |
| Right Shoulder of ♒. | 326 19 | 2 13 | S | 1 20 | 29 N | | 327 39 | 1 44 |
| Fomahant, ♒. | 338 46 | 31 39 | S | 1 25 | 31 N | | 340 11 | 31 8 |
| Scheat, Pegasus. | 341 9 | 25 56 | N | 1 12 | 32 S | | 342 11 | 26 28 |
| Marchab, Pegasus. | 341 15 | 3 5 | N | 1 15 | 32 S | | 342 30 | 13 37 |
| Mouth of Southern Fish. | 344 9 | 1 7 | N | 1 17 | 33 S | | 345 26 | 1 40 |
| Head of Andromeda. | 356 59 | 26 54 | N | 1 17 | 34 S | | 358 16 | 27 28 |
| Cassiopeæ's Chair. | 357 5 | 56 58 | N | 1 15 | 34 S | | 358 20 | 57 32 |
| End of Pegasus Wing. | 358 14 | 12 58 | N | 1 16 | 34 S | | 359 30 | 13 32 |
| Northern the Whales Tail | 359 49 | 11 1 | S | 1 18 | 34 S | | 1 7 | 10 27 |

## *Of the Use of this Table.*

The First Column on the left Hand is the Names of the *Stars*. The Second Column shews the Degrees and Minutes of *Right Ascension* for the Year 1600. The Third the *Declination* for the same Year. The Fourth shews whether the *Declination* be *North* or *South*; N stands for *North*, S for *South*. The Fifth shews the Difference in Degrees and Minutes of *Right Ascension* of the *Stars*, between the Years 1600. and 1670. The Sixth shews the Difference of *Declination*; and whether it be *North* or *South*. The Seventh shews the *Right Ascention* in Degrees and Minutes for the Year 1670. The Eight shews the *Declination* in Degrees and Minutes for the same Year.

By this *Table* you may perceive the Fixed *Stars* increase in *Right Ascension*, till they come to the *Vernal Colour*; from whence

whence the number of their *Right Aſcenſion* is reckoned: and by the Column of their Difference of *Right Aſcenſion*, you may ſee how much they increaſe in 70 Years. And if you would know how much they increaſe for any other number of Years, you muſt find what proportion they have to 70, and the ſame proportion the Difference of the *right Aſcenſion* of the *Stars* will have to the difference in the *Table*.

*Example.*

I would know the Difference of *Right Aſcenſion* the *Pole-Star* will have in 35 Years. I find in the fifth Column the Difference of *Right Aſcenſion* of the *Pole Star* to be 3 Degrees 59 Minutes; Therefore by the *Rule of Proportion*, I ſay, if 70 Years give 3 Degrees 59 Minutes, 35 Years ſhall give 1 Degree 59½ Minutes, and ſo proportionably for any other Number of Years.

Though this Rule ſerves for finding the Difference of *Right Aſcenſion* of any *Star*; yet it will not ſerve for finding the difference of any *Stars Declination*. For the *Stars* on the *North* ſide the *Equinoctial* between the *Hyemnal* and *Solſtitial Colures*, and on the *South* ſide the *Equinoctial* between the *Solſtitial* and *Hyemnal Colures* increaſe in *Declination*. But the *Stars* on the *South* ſide the *Equinoctial* between the *Hyemnal* and *Solſtitial Colures*, and on the *North* ſide the *Equinoctial* between the *Solſtitial* and *Hyemnal Colures*, decreaſe in *Declination*, as you may yet more plainly ſee by the Globe if you bring 66½ Degrees of the *Meridian* to the *North* ſide of the *Horizon*, and ſcrew the *Quadrant of Altitude* to 66½ Degrees in the *Zenith*, and *Declination* of the *Pole* of the *Ecliptick*; and bring the *Hyemnal Colure* to the *Meridian*, for ſo ſhall the Pole of the *Ecliptick* be joined with the Center of the *Quadrant of Altitude*, and the *Ecliptick* with the *Horizon*; and all the Circles that the ſeveral Degrees on the *Quadrant* make in a Revolution from *Weſt* to *Eaſt* upon the *Poles* of the *Ecliptick*, repreſent the great Revolution of every *Star* that each Degree on the *Quadrant* cuts. And thus demonſtratively will be repreſented the Progreſs of the Fixed *Stars* through every Degree of *Longitude*, and by conſequence the *Alteration* of their *right Aſcenſion* and *Declination*. For, imagining that Degree of the *Quadrant of Altitude* to be the *Star*, which juſt reaches the

*Star*;

*Star*; you may by turning about the *Quadrant*, see how Obliquely the *Star* (or the Degree representing the *Star*) either Moves about, or cuts the *Equinoctial*, and all Circles *parallel* to the *Equinoctial*; and thereby Observe it some times to *Incline* in *Motion* to, and other times to Decline in Motion from the *Equinoctial*. But how long Time it will be ere the *Star* Inclines to, or Declines from the *Equinoctial*, you may know by finding the Distance of *Longitude* in Degrees it hath from either the *Solstitial* or *Hyemnal Colure*; and with respecting the foregoing Rules in its Position, you may by the *Table* in Book 1. Chap. 3. Sect. 3. satisfie your self.

*Example.*

The most *Northerly Star* in the *Girdle of Orion* doth yet Decrease in *Declination*. But I would know how long it shall Decrease; Therefore by the 32 Probleme, I find the *Longitude* of that *Star* to be for the Year 1670. 77 Degrees 51 Minutes, which Subducted out of 90 (the Distance of the *Solstitial Colure* from the *Equinoctial*) leaves 12. 9 for the Distance of that *Star* from the *Solstitial Colure*. Therefore by the *Table* aforesaid, I find what number of Years answers to the motion of 12 Degrees 9 Minutes. And because I cannot find exactly the same number of Degrees and Minutes in the *Table*, I take the number the neareſt to it, which is 14 Degrees 10 Min: and that is the Motion of the *Ecliptick* in 1000 Years. But because this 14 Degrees 10 Minutes is 2 Degrees 1 Minute too much, I seek 2 Degrees 1 Minute in the *Table*, and the number of Years against it I would Subduct from the number of Years against 14 Degrees 10 Min. and the Remainder would be the number of Years required: But neither can I find 2 Degrees 1 Minute, therefore I must take the number of Degrees and Minutes neareſt to it, which is 2 Deg. 50 Min. and that yields 200 Years; which subducted out of 1000 leaves 800 Years. But because this is also too much by the Motion of 49 Minutes, Therefore I seek for 49 Minutes in the Table, and Subduct the number of Years against it from 800, and the Remainder would be the number of years required. But neither is 49 Min. in the Table, Therefore I take the neareſt to it, which is 51 Min. and that yields 60 Years; which Subducted out of 800, leaves 740. But this is likewise too much by the

the Motion of two Minutes. Therefore I ſeek 2 Min. in the *Table*, but cannot find it nearer than 2½, and againſt it I find 3 Years, which 3 Years I ſubduct out of 740, and the Remainder is 737 the number of Years required. You may if you pleaſe for exactneſs, ſubduct for the ½ Minutes 8 Months; ſo have you 736 Years 4 Months, for the Time that the moſt *Northerly Star* in the *Girdle of Orion* will Decreaſe in *Declination*, after the Year 1670, which will be till *Ann. Dom.* 2406, after which time it will increaſe in *Declination* for 12706 Years together, till it come to have 47 Degrees 8 Minutes of Declination: At which time it will be in or very near the place of the moſt *Southerly Star* of the *Southern Crown*, and that *Star* in its place.

And thus the *Pole Star* is now found to Increaſe in *Declination*, and will yet this 421 Years: After which time it will Decreaſe in *Declination* for 12706 Years together, till it come to be within 42 Degrees 42 Minutes of the *Equinoctial*, in the void ſpace now between *Draco* and *Lyra*; at which time *Lyra* will be almoſt as near the *Pole*, as the *Pole Star* now is; and then the moſt proper to be the *Northern Pole Star*: And the laſt *Star* in the *Stalk of the Dove's Mouth* will be then very near the *Southern Pole*, and therefore moſt fit to be the *Southern Pole Star*.

## PROB. XXVIII.

*The place of the* Sun *or any* Star *given, to find the* Oblique Aſcenſion, *and the* Oblique Deſcenſion, *in any given* Latitude.

THE *Globe* Rectified, Bring the place of the *Sun* or *Star* to the *Meridian* under the *Horizon*, and the Degree of the *Equinoctial* that comes to the *Meridian* with it under the *Horizon* is the Degree of *Right Deſcenſion*. If the *Sun* or *Star* will reach no part of the *Horizon* under the *Horizon*, they have no *Right Deſcenſion*.

### *For the* Oblique Aſcenſion.

Bring the place of the *Sun* or the *Star* to the *Eaſt* ſide the *Horizon*, and the Degree of the *Equator* cut by the *Horizon*, is the Degree of *Oblique Aſcenſion* of the *Sun* or *Star*.

For

*For the* Oblique Descention.

Bring the place of the *Sun* or *Star* to the *West* side the *Horizon*, and the Degree of the *Equinoctial* cut by the *Horizon* is the Degree of *Oblique Descension*. They need no *Example*.

## PROB. XXIX.

*Any Place on the* Terrestrial Globe *being given, to find its* Antipodes.

BRing the given Place to the *Meridian*, so may you (as by the first Probleme) see its *Longitude* and *Latitude*; then turn about the *Globe* till 180 Degrees of the *Equator* pass through the *Meridian*; and keeping the *Globe* to this *Position*, number on the *Meridian* 180 Degrees from the *Latitude* of the given Place; and the point just under that Degree is the *Antipodes*.

*Example.*

I would find the *Antipodes* of *Cuida Real*, an Inland Town of the *West-Indies*, which lies upon the River *Parana*, an Arm of *Rio de la Plata*: Therefore I bring *Cuida Real* to the *Meridian*, and find (as by the first Problem) its *Latitude* 23. 50. *South*; and its *Longitude* 338 Degrees: Then I turn about the *Globe* till 180 Degrees of the *Equator* pass through the *Meridian*; and keeping the *Globe* to that position, I number so many Degrees *North Latitude* as *Parana* hath *South*, viz. 23. 50. and just under that Degree, I find *Lamoo*, a Town lying upon the Coast of *China*, in the Province of *Quincii*: Therefore I say *Lamoo* is just the Antipodes of *Cuida Real*.

*Another way.*

Bring the given Place to the *North* or *South* point of the *Horizon*, and the point of the *Globe* denoted by the opposite point of the *Horizon* is the *Antipodes* of the given *Place*.

PROB.

## PROB. XXX.

### *To find the* Perecii *of any given Place, by the* Terrestrial Globe.

BRing your given Place to that side the *Meridian* which is in the *South* Notch of the *Horizon*, and follow the *Parallel* of that Place on the *Globe*, till you come to that side the *Meridian*, which is in the *Northern* Notch of the *Horizon*, and that in the *Perecii* of your Place.

## PROB. XXXI.

### *To find the* Antecii *of any given Place, upon the* Terrestrial Globe.

BRing your given Place to the *Meridian*, and find its *Latitude* by the first Probleme: If it have *North Latitude*, count the same number of Degrees on the *Meridian* from the *Equator Southwards*; but if it have *South Latitude*, count the same number of Degrees from the *Equator Northwards*, and the Point of the *Globe* directly under that number of Degrees, is the *Antecii* of your Place.

## PROB. XXXII.

### *To find the* Longitude *and* Latitude *of the* Stars *by the* Celestial Globe.

THE *Quadrant of Altitude* will reach but 90 Degrees, as was said Prob. 9. Therefore if the *Star* you enquire after be on the *North* side the *Ecliptick*; Elevate the *North Pole* $66\frac{1}{2}$ Degrees above the *North* side the *Horizon*: If on the *South* side the *Ecliptick*, you must Elevate the *South Pole* $66\frac{1}{2}$ Degrees above the *South* side the *Horizon*: Then bring the *Solstitial Colure* to the *Meridian* on the *North* side the *Horizon*, and screw the *Quadrant of Altitude* to the *Zenith*, which will be in 23 Degrees 30 Minutes from the *Pole* of the *World*: So shall the *Ecliptick* lye in the *Horizon*, and the *Pole* of the *Ecliptick* also lye under the Center of the *Quadrant of Altitude* (as was

ſhewed Prob. 27.) Now to find the *Longitude* of any *Star*, do thus, Turn the *Quadrant of Altitude* about, till the Graduated Edge of it lie on the *Star*; and the Degree in the *Ecliptick* that the *Quadrant* touches, is the *Longitude* of that *Star*.

### *Example, For a* Star *on the* North *ſide the* Ecliptick.

I would know the *Longitude* of *Marchab*, a Bright *Star* in the Wing of *Pegaſus*: I find it on the *North* ſide the *Ecliptick*; Therefore I Elevate the *North Pole*, and placing ♎ on the *North* ſide the *Meridian*, I ſcrew the *Quadrant of Altitude* to the *Zenith*, as aforeſaid; then laying the Edge of the *Quadrant of Altitude* upon that *Star*, I find that the end of it reaches in the *Ecliptick* to ♐ 18.56. Therefore I ſay, the *Longitude* of *Marchab* is ♐ 18.56.

### *For the* Latitude *of a* Star.

The Degree of the *Quadrant of Altitude* that touches the *Star*, is the *Latitude* of the *Star*.

### *Example.*

The *Globe* and *Quadrant* poſited as before, I find 19 Degr. 26 Min. (accounted upwards on the *Quadrant*) to touch *Marchab* aforeſaid: Therefore I ſay, the *Latitude* of *Marchab* is 19 Degrees 26 Minutes.

And thus by Elevating the *South Pole*, and placing the *Globe* and *Quadrant of Altitude* as aforeſaid, I ſhall find *Canicula* have 15 Degrees 57 Minutes *South Latitude*, and 21 Degrees 18 Minutes in ♋ *Longitude*.

## PROB. XXXIII.

### *To find the* Diſtance *between any two* Places, *on the* Terreſtrial Globe.

THis may be performed either with the *Quadrant of Altitude*, or with a pair of *Compaſſes*; with the *Quadrant of Altitude*, thus: Lay the lower end thereof to one Place, and ſee what Degree reaches the other Place, for that is the number of

of Degrees between the two Places. If you Multiply that number of Degrees by 60, the Product ſhall be the number of *Engliſh Miles* between the two Places.

*Example.*

I would know the *Diſtance* between *London* and the moſt *Eaſterly* Point of *Jamaica*; I lay the lower end of the *Quadrant of Altitude* to *Jamaica*, and extending the other end towards *London*, I find 68½ Degrees comprehended between them; Therefore I ſay 68½ is the number of Degrees comprehended between *London* and *Jamaica*.

If you would find the Diſtance between them with your *Compaſſes*, you muſt pitch one Foot of your *Compaſſes* in the *Eaſt* Point of *Jamaica*, and Open your *Compaſſes*, till the other Foot reach *London*; and keeping your *Compaſſes* at that diſtance, apply the Feet to the *Equinoctial Line*, and you will find 68½ Degrees comprehended between them, as before.

If you Multiply 68½ by 60, it gives 4114 *Engliſh Miles*.
If you Multiply it by 20, it gives 1370 *Engliſh Leagues*.
If you Multiply it by 17½, it gives 1199 *Spaniſh Leagues*.
If you Multiply it by 15, it gives 1054 *Dutch Leagues*.

## PROB. XXXIV.

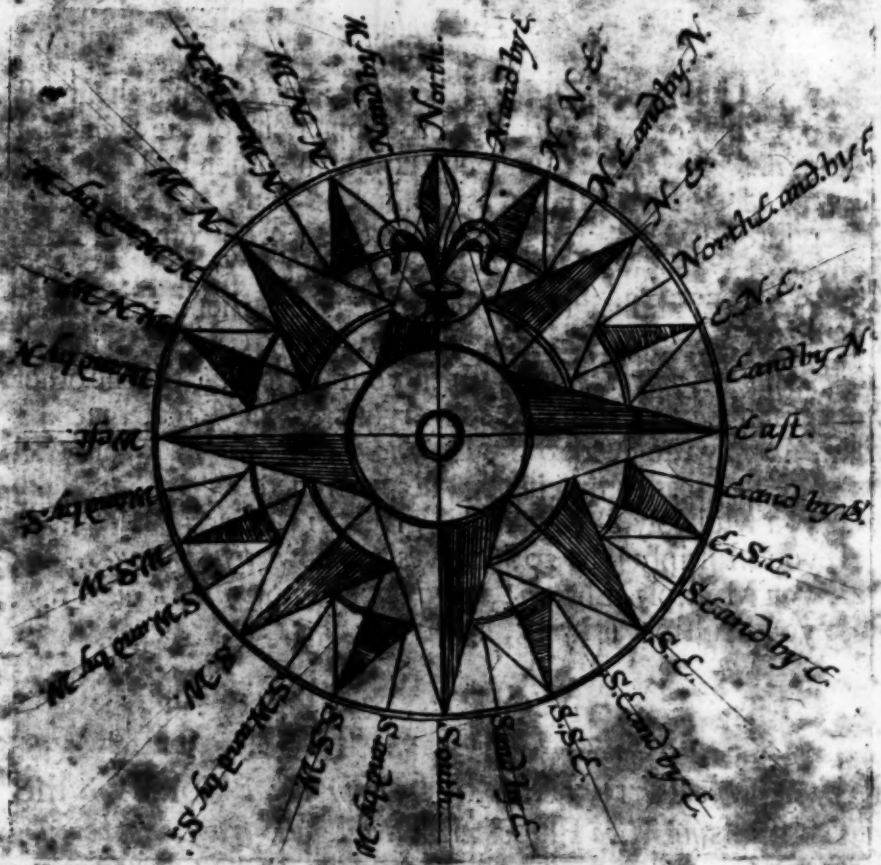
*To find by the* Terreſtrial Globe, *upon what* Point of the Compaſs *any two* Places *are Situate one from another.*

FInd the two Places on the *Terreſtrial Globe*, and ſee what *Rhumb* paſſes through them; for that is the Point of the *Compaſs*, they bear upon.

*Example.*

*Briſtol* and *Bermudas* are the Places. I examine what *Rhumb* paſſes through them both; and becauſe I find no *Rhumb* to paſs immediately through them both, therefore I take that *Rhumb* which runs moſt Parallel to both the Places; which in this *Example* is the Tenth *Rhumb*, counted from the *North* towards the left Hand; and is called, as you may ſee by this following

Figure *West South West*; Therefore I say, *Bermudos* lies Situate from *Bristol West South West*; and by contraries, *Bristol* lies Situate from *Bermudos East North West*.




## PROB. XXXV.

### *To find by the* Celestial Globe, *the* Cosmical Rising *and* Setting *of the* Stars.

WHEN any *Star* Rises with the *Sun*, it is said to Rise *Cosmically*.

And when any *Star* Sets when the *Sun* Rises, it is said to Set *Cosmically*.

To find these, Rectifie the *Globe* to the *Latitude* of your Place,

Place, and bring the place of the *Sun* to the East side the *Horizon*, and the *Stars* then cut by the Eastern Semi-circle of the *Horizon*, Rise *Cosmically*; and those *Stars* cut by the Western Semi-circle of the *Horizon*, Set *Cosmically*.

*Example.*

*November 9.* I would know what *Stars* Rise and Set *Cosmically*, here at *London*. The *Suns* place found, as by the Third Probleme, is ♏ 27. Therefore I bring ♏ 27 to the East side the *Horizon*, and in the Eastern Semi-circle, I find Rising with the *Sun* the Right Wing of *Cygnus*, the *Star* in the end of *Aquila's* Tail, *Serpentarius* and *Centaurus*: Therefore these *Constellations* are said to Rise *Cosmically*. In the Western Semi-circle of the *Horizon* I find Setting *Andromeda*, the Triangle, *Taurus*, *Orion*, *Canis major*, and *Argo Navis*; Therefore I say, these *Constellations* Set *Cosmically*.

## PROB. XXXVI.

*To find by the* Celestial Globe, *the* Acronical Rising *and* Setting *of the* Stars.

THE *Stars* that Rise when the *Sun* Sets, are said to Rise *Acronically*. And,

The *Stars* that Set with the *Sun*, are said to Set *Acronically*.

To find these, Rectifie the *Globe* to the *Latitude* of your Place, and bring the place of the *Sun* to the *West* side the *Horizon*; and the *Stars* that cut by the *Eastern* Semi-circle of the *Horizon*, Rise *Acronically*: And those *Stars* cut by the *Western* Semi-circle of the *Horizon*, Set *Acronically*.

*Example.*

*November 9.* I would know what *Stars* Rise and Set *Acronically* here at *London*. The *Suns* place, as before, is ♏ 27. Therefore I bring *Scorpio* 27 to the West side the *Horizon*; and in the Eastern Semi-circle I find Rising the *Southern Fish*, *Fomahant*, *Cetus*, *Taurus*, *Auriga*, and the *Feather in Castor's Cap*. Therefore these *Constellations* are said to Rise *Acronically*. In the

the *Western* Semi-circle of the *Horizon* I find Setting the *Lyons Tail*, *Virgo*, *Scorpio*, and *Sagittarius*; therefore I say these *Constellations Set Acronically*.

## PROB. XXXVII.

### *To find by the* Celestial Globe, *the* Heliacal Rising *and* Setting *of the* Stars.

WHen a *Star*, formerly in the *Suns* Beams, gets out of the *Suns* Beams, it is said to *Rise Heliacally*. And,

When a *Star*, formerly out of the *Suns* Beams, gets into the *Suns* Beams, it is said to *Set Heliacally*.

A *Star* is said to be in the *Sun* Beams, when it is made inconspicuous, by reason of its nearness to the *Suns* Light. The bigger *Stars* are discernable more near the *Suns* Light, than the lesser are; for, *Stars* of the First *Magnitude* may (according to the received Rules of Ancient Authors) be seen when the *Sun* is but 12 Degrees below the *Horizon*; but *Stars* of the Second *Magnitude* cannot be seen, unless the *Sun* be 13 Degrees below the *Horizon*: *Stars* of the Third *Magnitude* require the *Sun* to be 14 Degrees below the *Horizon* e're they can be seen; of the Fourth *Magnitude* 15 Degrees, of the Fifth *Magnitude* 16 Degrees, of the Sixth *Magnitude* 17 Degrees; the *Nebulous* ones 18 Degrees. Yet this Rule is not so certain, but that either Clear or Cloudy Weather may alter it. Read more of this Subject in Mr. *Palmer* on the *Planisphere*, Book 4. Chap. 20.

Now to find the Time that any *Star* shall *Rise Heliacally*, do thus; Rectifie the *Globe* and *Quadrant of the Altitude* to your *Latitude*, then bring the given *Star* to the *East* side the *Horizon*, and turn the *Quadrant of Altitude* into the *West* side, and see what Degree of the *Ecliptick* is elevated so many Degrees above the *Horizon* as the *Magnitude* of the *Star* you enquire after requires, according to the foregoing Rules; for the opposite Degree of the *Ecliptick*, is the Degree the *Sun* shall be in when the *Star Rises Heliacally*. Having the Degree of the *Ecliptick* the *Sun* is in, you may find the Day of the Month by the Fourth Probleme.

*Example.*

*Example.*

I would know when *Cor Leonis* shall *Rise Heliacally* here at *London*; Therefore I Rectifie the *Globe* and *Quadrant of Altitude* for *London*, and bring *Cor Leonis* to the *East* side the *Horizon*, and turn the *Quadrant of Altitude* into the *West*; and because *Cor Leonis* is a *Star* of the First *Magnitude*, therefore I see what Degree of the *Ecliptick* is Elevated in the *West* side the *Horizon* 12 Degrees on the *Quadrant of Altitude*, and find *Pisces* 9 Degrees. Now the Degree of the *Ecliptick* oppoite to ♓ 9. is ♍ 9. Therefore I say, when the *Sun* comes to ♍ 9 Degrees (which by the Fourth Probleme I find is *August* 23.) *Cor Leonis* shall *Set Heliacally*.

*For the* Heliacal Setting.

The *Globe*, &c. Rectified, as before: Bring the *Star* to the *West* side the *Horizon*, then see what Degree of the *Ecliptick* is Elevated on the *Quadrant of Altitude*, on the Eastern side the *Horizon*, so many Degrees as the *Stars Magnitude* requires; for when the *Sun* comes to the oppoite Degree of the *Ecliptick*, that *Star* shall *Set Heliacally*.

*Example.*

I would know when *Bilanx*, a *Star* in the Beam of the Scales, will *Set Heliacally* here at *London*. The *Globe* and *Quadrant* rectified, I bring *Bilanx* to the *West* side the *Horizon*, and turn the *Quadrant of Altitude* into the *East*; Then I examine what Degree of the *Ecliptick* is elevated 13 Degrees of the *Quadrant of Altitude*, (because *Bilanx* is a *Star* of the Second *Magnitude*) and find ♉ $4\frac{1}{2}$ oppoite to ♉ $4\frac{1}{2}$ is *Scorpio* $4\frac{1}{2}$; Therefore I say, when the Sun comes to *Scorpio* $4\frac{1}{2}$, (which by Prob. 4. will be *October* 18.) *Bilanx* shall *set Heliacally*.

## PROB. XXXVIII.

*To find the* Diurnal *and* Nocturnal *Arch of the* Sun *or* Stars, *in any given* Latitude.

THE *Semi-Diurnal Arch*, is the number of Degrees of the *Equinoctial* that passes thro' the *Meridian*, whiles the *Sun*, or any

any *Star* is ascending above the East side the *Horizon* to the *Meridian*.

To know the number of Degrees it contains, Rectifie the *Globe* to the given *Latitude*, and bring the Place of the *Sun* or *Star* to the East side the *Horizon*, and note what number of Degrees of the *Equinoctial* is then cut by the *Meridian*: Then remove the Place of the *Sun* or *Star* to the *Meridian*, and see again what number of Degrees of the *Equinoctial* is then cut by the *Meridian*, and subtract the former from the latter, and the Remainder shall be the number of Degrees of the *Sun* or *Stars Semi-Diurnal Arch*. But note, if the *Equinoctial* Point ♈ pass through the *Meridian*, while the *Sun* or *Star* is turned from the East side the *Horizon* to the *Meridian*, then you must subtract the number of Degrees of the *Equinoctial* cut by the *Meridian*, when the *Sun* or *Star* is at the East side the *Horizon* from 360 Deg. and to the Remainder add the number of Degrees of the *Equinoctial* that comes to the *Meridian*, with the place of the *Sun* or *Star*, and the Sum of them both, is the number of Degrees of the *Sun* or *Stars Semi-diurnal Arch*; which being doubled, is the number of Degrees of the whole *Diurnal Arch*; and which being subtracted from 360, gives the *Nocturnal Arch*.

### *Example of the* Sun.

Having rectified the *Globe*, I would, *May* 10. know the *Diurnal Arch* of the *Sun*: His place, found by Prob. 3. is ♉ 29. Therefore I bring ♉ 29 to the *East* side the *Horizon*, and find then at the *Meridian* 299 Deg. 30 Min. of the *Equinoctial*; then I turn the place of the *Sun* to the *Meridian*, and find 56 Degr. 30 Min. of the *Equinoctial* come to the *Meridian* with it. Here the *Equinoctial* Point ♈ passes through the *Meridian*, while the *Sun* moves between the *Horizon* and the *Meridian*; Therefore, as aforesaid, I subtract the First number of Degrees and Minutes, *viz.* 299 Degr. 30 Min. from 360 Degr. and there remains 60 Degr. 30 Min. for the number of Degr. and Min. contained between the Degree of the *Equinoctial* at the *Meridian*, and the *Equinoctial* Point *Aries*; and to this 60 Deg. 30 Min. I add the Second number of Degr. and Min. *viz.* 56 Degr. 30 Min. the number of Degr. and Min. between the Point *Aries*, and the Deg. of the *Equinoctial* at the *Meridian*, and they make together 117 Degr. for the *Suns Semi-diurnal*

*Arch*:

*Arch*: By doubling of which, you have 234 Degrees for the *Suns Diurnal Arch*; and by Subtracting 234 (the *Diurnal Arch*) from 360, you have 126 Degrees, for the *Suns Nocturnal Arch*.

*Example, for a Star.*

I take *Sirius*, a Bright *Star* in the *Great Dogs Mouth*. The *Globe* Rectified, as before, I bring *Sirius* to the *East*-side the *Horizon*, and find then 29 Degrees 30 Min. of the *Equinoctial* at the *Meridian*, then I turn *Sirius* to the *Meridian*, and find 97 Degrees 38 Minutes of the *Equinoctial* come to the *Meridian* with it. Therefore I subtract the first Number, *viz.* 29 Deg. 30 Minutes, from the Second, 97. 38. and the Remains is 68 Degrees 8 Minutes, for the *Semi-Diurnal Arch* of *Sirius*.

His *Nocturnal Arch* you may find as before.

## PROB. XXXIX.

*To find the* Azimuth *and* Almicantar *of any* Star.

THis Probleme is like the 22 and 23 Problemes, which shew the finding the *Azimuth* and *Almicantar* of the *Sun*; only whereas there you were directed to bring the Degree of the *Sun* to the *Quadrant of Altitude*, you must now bring the *Star* proposed to the *Quadrant of Altitude*; and by the Directions in those Problemes, the Resolution will be found.

## PROB. XL.

*To find the* Hour *of the* Night, *by Observing two known* Stars *in one* Azimuth *or* Almicantar.

REctifie the *Globe*, *Quadrant*, and *Hour-Index*. Then find the two known *Stars* on the *Globe*; and if the two *Stars* be in one *Azimuth*, turn about the *Globe* and *Quadrant* of *Altitude*, till you can fit the two *Stars* to lye under the Graduated Edge of the *Quadrant of Altitude*; so shall the *Index* of the *Hour-Circle* Point at the Hour of the Night. If

the two *Stars* be in one *Almicantar*. Turn the *Globe* forward or backward till the two *Stars* come to such a Position, that by moving the *Quadrant of Altitude*, the same Degree on it will lye on both the *Stars*; so shall the *Index* of the *Hour-Circle* point at the Hour of the Night.

## PROB. XLI.

*The* Hour *given that any* Star *in* Heaven *comes to the* Meridian, *to know thereby the Place of the* Sun, *and by consequence the* Day *of the* Month, *though it were lost.*

BRing the *Star* proposed to the *Meridian*, and turn the *Index* of the *Hour-Circle* to the Hour given; then turn about the *Globe* till the *Index* point at the Hour of 12 for Noon; and the place of the *Sun* in the *Ecliptick* shall be cut by the *Meridian*.

### *Example.*

*March* 7. at 11 a Clock at Night the *Pointers* come to the *Meridian* of *London*. Therefore I place the *Pointers* (on the *Celestial Globe*) under the *Meridian*, above the *Horizon*, and turn the *Index* of the *Hour-Circle* to 11 past Noon; Afterwards I turn back the *Globe* till the *Index* point to 13 at Noon; Then looking in the *Ecliptick*, I find the *Meridian* cut in *Pisces* 26 Degrees 45 Minutes; Therefore I say, when the *Pointers* come to the *Meridian* at 11 a Clock at Night, the place of the *Sun* is *Pisces* 26. 45. Having thus the place of the *Sun*, I may find the *Day* of the *Month* by the Fourth Probleme; and so either know the Day that the *Pointers* come to the *Meridian* at 11 Clock at Night, or any other Hour given.

The Day of the Month might also be found by the *Declination*, and the Quarter of the *Ecliptick* the *Sun* is in, given; For the *Meridian* will cut the Degree of the *Suns* place in the *Ecliptick* in the *Parallel* of *Declination*: So that having respect to the Quarter of the *Ecliptick*, you'll find the *Suns* place; and having the *Suns* place, you may (as aforesaid) find the Day of the Month.

PROB.

## PROB. XLII.

### *The* Day *of the* Month *given to find in the* Circle *of* Letters *on the Plain of the* Horizon, *the* Day *of the* Week.

THE ſeven Days of the Week, were by the Idolatry of the Ancient *Roman* Heatheniſh Times dedicated to the Honour of ſeven of their Gods, which we call *Planets*. The firſt is the moſt eminent, and therefore doubtleſs by them ſet in the firſt place, called *Dies Solis*, or the *Suns* Day: The ſecond *Dies Lunæ*, the *Moons* Day: The third *Dies Martis*, the Day of *Mars*, by us called *Tueſday*: The fourth *Dies Mercurii*, *Mercuries* Day, by us called *Wedneſday*, from *Woden*, an Idol the *Saxons* worſhip'd, to whoſe Honour they dedicated that Day, and is by all thoſe *Germain* Nations ſtill called *Wodenſdagh*: The fifth *Dies Jovis*, *Jupiter* or *Joves* Day; which doubtleſs the *Saxons* (from whom probably we receive it) call'd *Donderdagh*, becauſe *Jupiter* is the God of Thunder; and we either by Corruption, or for ſhortneſs, or both, call'd it *Thurſday*: The ſixth *Dies Veneris*, the Day of *Venus*: But the *Saxons* transferring her Honour to another of their Goddeſſes, named *Fria*, call'd it *Fridagh*; and we from them call it *Friday*: The ſeventh is *Dies Saturni*, *Saturns* Day.

The ſame Day of the Month in other Years happens not on the ſame Day of the Week, therefore the *Dominical Letter* for one Year is not the ſame, it is the next: Now becauſe you cannot come to the knowledge of the Day of the Week, unleſs you firſt know the *Sundays Letter*, therefore have I in Prob. 53. inſerted a Table of Mr. *Palmer's*, by which you may find the *Dominical* or *Sundays Letter* for ever; and having the *Dominical Letter*, you may in the Circle of Letters on the *Horizon* find it near the Day of that Month, and count that for *Sunday*, the next under it for *Monday*, the next under that for *Tueſday*, and ſo in order, till you come to the Day of the Month.

### *Example.*

I would know what Day of the Week, *June* 1. *Anno* 1658. *Old Stile*, falls on; I find by the *Table* aforeſaid, the *Dominical*

Letter is C, then I look in the *Calender* of *Old Stile* for *June* 1. and againſt it I find Letter E, which becauſe it is the ſecond Letter in order from C, therefore it is the ſecond Day in order from *Sunday*, which is *Tueſday*.

## PROB. XLIII.

### *The* Azimuth *of any* Star *given, to find its* Hour *in any given* Latitude.

THe *Hour of a Star* is the number of Hours that a *Star* is diſtant from the *Meridian*. To find which, Rectifie the *Globe* and *Quadrant of Altitude*, and bring the *Star* propoſed to the Meridian, and the *Index* of the *Hour-Circle* to 12. Then place the lower end of the *Quadrant of Altitude*, to the given *Azimuth* in the *Horizon*, and turn the *Globe* till the *Star* come to the Graduated Edge of the *Quadrant of Altitude*; ſo ſhall the *Index* of the *Hour-Circle* point at the *Hour of the Star*. Only this caution you muſt take; if the *Star* were turned from the *Meridian* towards the *Eaſtern*-ſide of the *Horizon*, you muſt Subtract the number of Hours the *Index* points at from 12, and the Remainder ſhall be the *Hour of the Star*. But if the *Star* were turned from the *Meridian* towards the *Weſt*-ſide of the *Horizon*, the *Hour-Index* points at, is (without more ado) the *Hour of the Star*.

## PROB. XLIV.

### *How you may learn to know all the* Stars *in* Heaven, *by the* Celeſtial Globe.

REctifie the *Globe*, *Quadrant*, *Hour-Index*, and *Horizon*, as by Prob. 2. then turn about the *Globe*, till the *Index* of the *Hour-Circle* point at the Hour of the Night on the *Hour-Circle*. Then if every *Star* on the *Globe* had a Hole in the midſt, and your Eye were placed in the Centre of the *Globe*, you might by keeping your Eye in the Centre, and looking through the Hole of any *Star* on the *Globe*, ſee its *Match* in *Heaven*; that is, the ſame *Star* in *Heaven*, which that *Star* on the *Globe* repreſents: For from the Centre of the Globe, there proceeds a ſtraight Line

Line through the *Star* on the *Globe*, even to the ſame *Star* in *Heaven*. Therefore, thoſe *Stars* that are in the *Zenith* in *Heaven*, will then be on the *Zenith* on the *Globe*; thoſe that are in the *Eaſt* in *Heaven*, will be in the *Eaſt* on the *Globe*; thoſe in the *Weſt* in *Heaven*, in the *Weſt* on the *Globe*; and thoſe *Stars* that are in any *Altitude* in *Heaven*, will at the ſame time have the ſame *Altitude* on the *Globe*; ſo that if you ſee any *Star* in *Heaven* whoſe Name you deſire to know, you need but obſerve its *Azimuth* and *Altitude*; and in the ſame *Azimuth* and *Altitude* on the *Globe*, you may find the ſame *Star*; and if it be an Eminent *Star*, you will find its Name adjoined to it.

*Example.*

*December* 10. at half an Hour paſt 9 a Clock at Night here at *London*, I ſee two Bright *Stars* at a pretty Diſtance one from another in the *South*; I deſire to know the Names of them: Therefore having the *Globe* Rectified to the *Latitude* of *London*, and the *Quadrant of Altitude* ſcrewed to the *Zenith*, the *Hour-Index* alſo Rectified, and the *Horizon* poſited *Horizontally*, as by Prob. 2. I obſerve the *Altitude* of thoſe *Stars* in *Heaven* (either with a *Quadrant*, *Aſtrolabe*, *Croſs-ſtaff*, or the *Globe* it ſelf, as hath been ſhewed, Prob. 13. 16.) to be, the one 78 Degrees, the other 42 Degrees above the *Horizon*. Therefore, having their *Altitudes*, I count the ſame Number of Degrees as for the Firſt 78 upon the *Quadrant of Altitude* upwards, and turn it into the *South*, under the *Meridian*, and ſee what *Star* is under 78 Degrees; for that is the ſame *Star* on the *Globe* which I ſaw in *Heaven*. Now at the firſt Examination of the *Globe*, you may ſee that that *Star* is placed in the Eye of that *Aſteriſme*, which is called *Caput Meduſæ*, and indeed, that being the only *Star* of Note in that *Conſtellation*, bears the Name of the whole *Conſtellation*. The other *Stars* about it, you may eaſily know by their Situation: As ſeeing two little *Stars* to the *Weſtward* of that *Star* in *Heaven*, you may ſee on the *Globe*, that the hithermoſt is in the other Eye of *Caput Meduſæ*, and the furthermoſt in the *Hair* of *Snakes* of the ſame *Aſteriſme*. Looking a little to the *Southwards* of thoſe *Stars* in *Heaven*, you may ſee two other ſmall *Stars*, a little below thoſe in the *Eyes*: Therefore, to know thoſe alſo, you may look on the *Globe*, and ſee, that there is one on the

*Noſe*

Nose, and another *Star* in the Cheek of *Caput Medusæ*.

In like manner for the Second *Star* in the *Meridian*, which is 42 degrees above the *Horizon*: If you move the *Quadrant of Altitude* (as before) to the *South* or *Meridian*, and count 42 degrees upon the *Quadrant of Altitude*, you will find a *Star* of the Second Magnitude in the Mouth of the *Whale*: Therefore you may say, that *Star* in *Heaven* is in the Mouth of the *Whale*; and because close to it on the *Globe* is written *Menkar*; Therefore you may know the Name of that *Star* in *Heaven* is *Menkar*.

In the *South East and by South*, 56 degrees above the *Horizon*, I see a very Bright *Star* in *Heaven*; therefore I bring the *Quadrant of Altitude* to the *South East and by South* Point in the *Horizon*, and find under 56 degrees of the *Quadrant of Altitude* a Great *Star*, to which is set the Name *Oculus Tauri*; therefore I say, the Name of that Bright *Star* in *Heaven* is *Oculus Tauri*.

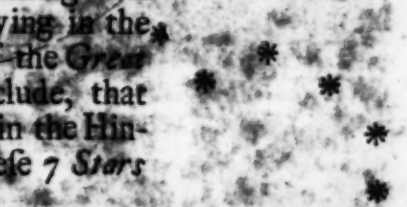
In the *South East* in *Heaven* you may see three Bright *Stars* lye directly in a straight Line from one another, the middlemost whereof is 25 degrees, or thereabouts, above the *Horizon*, therefore bring the *Quadrant of Altitude* to the *South East* Point of the *Horizon*, and about 25 degrees above the *Horizon* you will see the same Great *Stars* on the *Globe*, in the *Girdle of Orion*; therefore those *Stars* are called *Orion's Girdle*.

At the same Time, *South East and by East*, you have about 40 degrees above the *Horizon*, the Brightest *Star* in *Heaven*, called *Sirius*, in the Mouth of the *Great Dog*; *Canicula*, a Bright *Star* in the *Little Dog*, East and by South, about 25 degrees above the *Horizon*. *Cor Leonis* just Rising East North East; you have also at the same Time on the East side the *Horizon*, the Twins, *Auriga*, the *Great Bear*, and divers other *Stars*, eminent both for their Splendor and Magnitude.

In the *West* side the *Horizon* you have *South West and by West*, about 4 degrees above the *Horizon*, a bright *Star* in the Right Leg of *Aquarius*: And all along to the Southwards in *Cetus* the Whale, you have other Eminent Bright *Stars*: More upwards towards the *Zenith*, you have a Bright *Star* in the Line of the two *Fishes*: Higher yet, you have the First *Star* in ♈, an Eminent *Star*, because the first in all *Catalogues* that we have cognizance of; and therefore probably in the *Equinoctial Colure*, when the *Stars* were first reduced into *Constellations*; yet more near

near the *Zenith*, you have a Bright *Star* in the *Left Leg of Andromeda*: From thence towards the *North*, you find other very Eminent Bright Stars in *Cassiopea*, *Cepheus*, *Ursa minor*, in the *Tail* whereof is the *Pole Star*; and *Draco*, *Hercules*, where you turn back to *Lyra*, *Cygnus*, *Pegasus*, the *Dolphin*, &c. all which, or any other, you may easily know by their *Altitude* above the *Horizon*, and the Point of the Compass they bear upon.

Thus knowing some of the most Eminent Fixed *Stars*, you may by the Figure of the Rest come to the Knowledge of them also. For *Example*, Looking towards the *North North East* in *Heaven*, you may see Seven Bright *Stars*, constituted as in this Figure. Therefore looking towards the same Quarter on the *Globe*, you may (without taking their *Altitude*) see the same *Stars* lying in the same Figure in the Hinder Parts of the *Great Bear*; from whence you may conclude, that those *Stars* in *Heaven* are situate in the Hinder Parts of the *Great Bear*. These 7 *Stars* are by us called *Charles his Wain*.



Yet nevertheless you may see some *Stars* of Note in *Heaven*, which you shall not find on the *Globe*, and those in or near about the *Ecliptick*: They are called *Planets*, and cannot be placed on the *Globe*, unless it be for a particular Time, with Black Lead, or some such thing that may be rubb'd out again: Because they having a continual Motion, always alter their Places. Of those there are five in number, besides the *Sun* and *Moon*, which are also *Planets*, though they shew not like Stars. These five are called *Saturn*, *Jupiter*, *Mars*, *Venus*, *Mercury*; yet *Mercury* is very rarely seen, because he never Rising above an Hour before the *Sun*, or Setting above an Hour after, for the most part hath his Light so over-spread with the dazelling Beams of the Glittering *Sun*, that sometimes when he is seen, he seems rather to be a Mote in the *Suns* Beams, than a Body endowed with so much Brightness as *Stars* and *Planets* seem to be.

Now there are divers Ways (by some of which) you may at all Times know those *Planets* from the Fixed *Stars*: As first, their not Twinkling, for therein they differ from Fixed *Stars*; because they most commonly do Twinkle, but *Planets* never; unless it be *Mars*; and yet he Twinkles but very seldom neither.

*Secondly*, They appear of a considerable *Magnitude*, as some-

sometimes appears Greater by far than a *Star* of the First *Magnitude*, and ☽ many times Bigger than He. They are both Glistering *Stars* of a bright *Silver* Colour, but ☽ most Radiant, especially when She is in Her *Perigeon*. ☿ appears like a *Star* of the Second *Magnitude*, and is of a *Copperish* Colour. ♄ shews like a *Star* of the Third *Magnitude*, and is of a *Leaden* Colour; and he (of all others,) is most difficult to be known from a Fixed *Star*, partly because of his Minority, and partly because of the slowness of his Motion. ☽ is very seldom seen (as aforesaid,) unless it be in a Morning, when he Rises before the *Sun*, or in an Evening when he Sets after the *Sun*: He is of a pale whitish Colour, like *Quicksilver*, and appears like a *Star* of the Third *Magnitude*: He may be known by the Company he keeps, for he is never above 29 Degrees distant from the *Sun*.

*Thirdly*, The *Planets* may be known from the Fixed *Stars*, by their *Azimuths* and *Altitudes* observed, (as hath been taught before;) for if when you have taken the *Azimuth* and *Altitude* of the *Star* in *Heaven* you doubt to be a *Planet*, and you find not on the *Globe*, in the same *Azimuth* and *Altitude*, a *Star* appearing to be of the same *Magnitude* that that in *Heaven* appears to be, you may conclude, that that in *Heaven* is a *Planet*. Yet notwithstanding it may happen, that a *Planet* may be in the same Degree of *Longitude* and *Latitude* in the *Zodiack* that some Eminent Fixed *Star* is in, as in the Degree and Minute of *Longitude* and *Latitude*, that *Cor Leonis*, or the *Bright Eye*, or *Scorpions Heart* is in, and so may Eclipse that *Star*, by being placed between us and it; but that happens very seldom and rarely; but if you doubt it, you may apply your self to some other of the precedent and subsequent Rules here set down, for knowing *Planets* from Fixed *Stars*.

The *Fourth* way, is by shifting their Places; for the *Planets* having a continual Motion, do continually Alter their Places, as ☉ moves about half a Degree in a Day, ☽ about a whole Degree; but ♃ and ♄ move very slowly; ♃ not exceeding above 5 Minutes, and ♄ seldom above 2 Minutes. Yet by their Motions alone, the *Planets* may be known to be *Planets*, if you will precisely observe their Distance from any known fixed *Star* in or near the *Ecliptick*, as on this Night, and the next Night after, observe whether they retain the same Distance that they had the Night before, which if they do, then are they Fixed *Stars*; but if they do not, then are they *Planets*; yet this Caution is to be given you in this Rule also,

that

That the *Planets* ſometime, are ſaid to be *Stationary*, as not altering a Minute in Place, forwards or backwards, in 6 or 7 Days together. Therefore, if you find cauſe to doubt, whether your *Star* be a *Planet*, or a Fixed *Star*, you may, for the Help of your Underſtanding, conſer with ſome of the former Rules, unleſs you are willing to wait 8 or 9 Days longer, and ſo by Obſervation of its Motion, reſolve your ſelf. Or,

*Fifthly*, You may apply your ſelf to an *Ephemeris* for that Year, and ſee if on that Day you find any *Planet* in the Degree and Minute of the *Zodiack*, you ſee that *Star* you queſtion in *Heaven*; and if there be no *Planet* in that Degree of the *Zodiack*, you may conclude, it is no *Planet*, but a Fixed Star.

## PROB. XLV.

*How to hang the* Terreſtrial Globe *in ſuch a Poſition, that by the* Suns *Shining upon it, you may (with great delight) at once behold the Demonſtration of many Principles in* Aſtronomy *and* Geography.

TAke the *Terreſtrial* Ball out of the *Horizon*, and faſten a Thread on the *Brazen Meridian*, to the Degree of the *Latitude* of your Place; by this Thread hang the *Globe* in a place where the *Suns* Beams may have a free Acceſs to it: Then direct the *Poles* of the *Globe* to their proper *Poles* in *Heaven*, the *North Pole* to the *North*, and the *South Pole* to the *South*; and with a Thread faſtned to either *Pole*, brace the *Globe* ſo, that it do not turn from its Poſition: Then bring your Habitation to the *Meridian*, ſo ſhall your *Terreſtial Globe* be Rectified to correſpond in all reſpects with the *Earth* it ſelf, even as in *Prob.* 44. the *Celeſtial Globe* doth; the *Poles* of the *Globe* to the *Poles* of the *World*, the *Meridian* of the *Globe* to the *Meridian* of the *World*; and the ſeveral Regions on the *Globe* made correſpondent to the ſame Regions on the *Earth*: So that with great delight you may behold,

1. How the counterfeit *Earth* (like the true one,) will have one *Hemiſphere* Sun-ſhine Light, and the other Shadowed, and as it were Dark. By the Lightned *Hemiſphere*, you may ſee that it is Day in all Places that are Situate under it; for on them the *Sun* doth Shine, and that it is Night at the ſame time in thoſe Places

that are Situate in the Shadowed *Hemisphere*; for on them the *Sun* doth not shine; and therefore they remain in Darkness.

2. If in the middle of the Enlightned *Hemisphere*, you set a *Sperick Gnomon* Perpendicularly, it will project no Shadow, but shews, that the *Sun* is just in the *Zenith* of that Place; that is, directly over the Heads of the Inhabitants of that Place: And the Point that the *Spherick Gnomon* stands on, being removed to the *Meridian*, shews the *Declination* of the *Sun* on the *Meridian* for that Day.

3. If you draw a *Meridian* Line from one *Pole* to the other; in all Places under that Line, it is Noon: In those Places Situate to the *West*, it is Morning, for with them the *Sun* is *East*: And in those Places Situate to the *East*, it is Evening; for with them the *Sun* is *West*.

4. Note the Degree of the *Equator*, where the Enlightned *Hemisphere* is parted from the Shadowed; for the Number of Degrees of the *Equator*, intercepted between that Degree and the *Meridian* of any Place converted into Hours, (by accounting for every 15 Degrees 1 Hour,) shews, if the *Sun* be *Eastwards* of that Place, how long it will be e'er the *Sun* Rises, Sets, or comes to the *Meridian* of that Place, or if the *Sun* be *Westward* of that Place, how long it is since the *Sun* Rose or Set, or was at the *Meridian* of that Place.

5. The Inhabitants of all Places between the Enlightned and Shadowed *Hemisphere*, behold the *Sun* in the *Horizon*: Those *Westwards* of the *Meridian* Semi-Circle drawn through the middle of the Enlightned *Hemisphere*, behold the *Sun* Rising: Those is the *East*, see it Setting.

6. So many Degrees as the *Sun* reaches beyond either the *North* or *South Pole*, so many Degrees is the *Declination* of the *Sun*, either *Northwards* or *Southwards*: And in all those Places comprehended in a Circle, described at the Termination of the *Sun-shine*, about that *Pole*, it is always Day, till the *Sun* Decrease in *Declination*; for the *Sun* goes not Below their *Horizon*, as you may see by turning the *Globe* about upon its *Axis*; and in the opposite *Pole*, at the same Distance, the *Sun-shine* not reaching thither, it will be always Night, till the *Sun* Decrease in *Declination*; because the *Sun* Rises not above their *Horizon*.

7. If you let the *Globe* hang steddy, you may see on the *East*-side of the *Globe*, in what Places it grows Night; and on the *West*-

*West*-side the *Globe*, how by little and little the *Sun* encroaches upon it; and therefore makes it Day.

8. If you make of Paper or Parchment a narrow Girdle, to begirt the *Globe* just in the *Equinoctial*, and divide it into 24 equal Parts, to represent the 24 Hours of Day and Night, and mark it in order, with I,II,III, *&c.* to XII. and then begin again with I,II,III, *&c.* to the other XII. you may, by placing one of the XII. upon the *Equinoctial*, under the *Meridian* of your place, have a continual *Sun-Dial* of it, and the Hour of the Day given on it at once in two Places; one by the parting the Enlightned *Hemisphere* from the Shadowed on the *Eastern*-side, the other by parting the Enlightned *Hemisphere* from the Shadowed on the *Western*-side the *Globe*. Much more might be said on this Probleme: But the Ingenious Artist may, of Himself, find out diversities of Speculations: Therefore I forbear.

## PROB. XLVI.

### *To know by the* Terrestrial Globe *in the* Zenith, *of what Place of the* Earth *the* Sun *is.*

THis may be performed by the former Probleme in the Day-time, if the *Sun* shines, but not else. But to find it at all times, do thus: Bring the Place for your Habitation to the *Meridian*, and the *Index* of the *Hour-Circle* to 12; Then turn the *Globe Eastwards*, if After-noon; or *Westwards*, if Before-noon, till the *Index* of the *Hour-Circle* pass by so many Hours from 12, as your Time given is, either Before or After Noon: So shall the *Sun* be in the *Zenith* of that Place, where the *Meridian* intersects the *Parallel* of the *Suns Declination* for that Day.

### *Example.*

*May* 10. at Three Quarters of an Hour past 4 a Clock After-noon, I would know in what Place of the *Earth* the *Sun* is in the *Zenith*. My Habitation is *London*; therefore I bring *London* to the *Meridian*, and the *Index* of the *Hour-Circle* to 12. and becaufe it is After-noon, I turn the *Globe Eastwards*, till the *Index* passes through 4 Hours and 3 Quarters, or (which is all one,) till 70 Degrees 15 Minutes of the *Equator*, pass through

the *Meridian*. Then I find by *Prob.* 5. the *Suns Declination* is 20 Degrees 5 Minutes, which I find upon the *Meridian*, and in that Place, just under that Degree and Minute on the *Globe*, the *Sun* is in the *Zenith*: Which in this *Example* is in the *North-East Cape*, of *Hispaniola*.

Having thus found in what Place of the *Earth* the *Sun* is in the *Zenith*, bring that Place to the *Meridian*, and Elevate its respective *Pole* according to its respective *Elevation*, so shall all Places cut by the *Horizon* have the *Sun* in their *Horizon*. Those to the *Eastwards*, shall have the *Sun* Setting; those to the *Westwards*, shall have it Rising in their *Horizon*; those at the intersection of the *Meridian* and *Horizon*, under the Elevated *Pole*, have the *Sun* in their *Horizon* at Lowest, but Rising; those at the intersection of the *Meridian* and *Horizon*, under the Depressed *Pole*, have the *Sun* in their *Horizon* at Highest, but Setting. Thus in those Countries that are above the *Horizon*, it is Day-Light, and in those but 18 Degrees below the *Horizon*, it is *Twilight*: But in those Countries further below the *Horizon*, it is at that time dark Night: And those Countries within the *Parallel* of the same number of Degrees from the Elevated *Pole*, that the *Suns Declination* is from the *Equinoctial*, have the *Sun* always Above the *Horizon*, till the *Sun* have less respective *Declination* than the Elevated *Pole*; and those within the same *Parallel* of the Depressed *Pole*, have the *Sun* always Below their *Horizon*, till the *Sun* inclines more towards the Depressed *Pole*; as you may see by turning about the *Globe*; for in this Position, that Portion of the *Globe*, intercepted between the Elevated *Pole*, and the *Parallel* Circle of 20 Degrees 5 Minutes from the *Pole*, doth not Descend below the *Horizon*: Neither doth that Portion of the *Globe*, intercepted between the Depressed *Pole* and the *Parallel* Circle, within 20 Degrees 5 Minutes of that *Pole*, Ascend above the *Horizon*.

## PROB. XLVII.

*To find in what different Places of the* Earth, *the* Sun *hath the same* Altitude *at the same Time.*

Find by the former Probleme, in what Place of the *Earth* the *Sun* is in the *Zenith*, and bring that Place on the *Globe*

*Globe* to the *Zenith*, and on the *Meridian* (there) ſcrew the *Quadrant of Altitude*, and turn it about the *Horizon*, deſcribing Degrees of *Almicantars* thereby, as by *Prob.* 23. and all thoſe Countries in any *Almicantar* on the *Globe*, ſhall have the *Sun* Elevated the ſame number of Degrees above their *Horizon*. Thus thoſe Countries in the tenth *Almicantar*, ſhall have the *Sun* Elevated 10 Degrees above their *Horizon*; thoſe in the 20th *Almicantar*, ſhall have the *Sun* Elevated 20 Degrees above their *Horizon*; thoſe in the 30th, 30 Degrees *&c.* So that you may ſee, when the *Sun* is in the *Zenith* of any Place, all the Countries or Cities in one and the ſame *Almicantar*, have the *Sun* in one Height at the ſame time above their *Horizon*. But to find in what different Places the *Sun* hath the ſame Height at the ſame time, as well Before or After Noon, as at Full Noon; and that in Countries that have Greater *Latitude* than the *Suns* greateſt *Declination*, (and therefore cannot have the *Sun* in their *Zenith*,) requires another Operation.

Therefore, Elevate its reſpective *Pole* according to your reſpective *Latitude*; and let the Degree of the *Brazen Meridian* which is in the *Zenith*, repreſent your Habitation, and the Degree of the *Ecliptick* the *Sun* is in, repreſent the *Sun*. Then bring the *Sun* to the *Meridian*, and the *Index* of the *Hour-Circle* to 12, and turn the *Globe Eaſtwards*, if Before Noon; or *Weſtwards*, if After Noon, till the *Index* point to the Hour of the Day; then place the lower end of the *Quadrant of Altitude*, to the *Eaſt*-point of the *Horizon*, and move the upper-end (by ſliding the Nut over the *Meridian*,) till the Edge of the *Quadrant* touch the place of the *Sun*: Then ſee at what Degree of the *Meridian*, the upper-end of the *Quadrant of Altitude* touches the *Meridian*, and Subtract that Number of Degrees from the *Latitude* of your Place, and count the Number of Remaining Degrees on the *Meridian*; on the contrary-ſide, the Degree of the *Meridian*, where the upper-end of the *Quadrant of Altitude* touches the *Meridian*; and where that Number of Degrees ends on the *Meridian* in that *Latitude*, and your Habitations *Longitude*, hath the *Sun* the ſame Height at the ſame time.

*Example.*

*May* 10. at 53 Minutes paſt 8 a Clock in the Morning, I would

would know, in what Place the *Sun* ſhall have the ſame *Altitude* it ſhall have at *London*. *London*'s *Latitude* found by Prob. 1. is 51½ Degrees *Northwards*: And becauſe the Elevation of the *Pole* is equal to the *Latitude* of the Place, (as was ſhewed, Prob. 15.) therefore I Elevated the *North Pole* 51½ Degrees; ſo ſhall 51½ Degrees on the *Meridian*, be in the *Zenith*: This 51½ Degrees on the *Meridian*, repreſents *London*. The *Suns* place found by Prob. 3. is ♉ 29. Therefore I bring ♉ 29 to the *Meridian*, and the *Hour-Index* to 12 on the *Hour-Circle*: Then I turn the *Globe Eaſtwards* (becauſe it is Before noon,) till the *Index* point at 8 Hours 53 Minutes in the *Hour-Circle*, and place the lower end of the *Quadrant of Altitude* to the *Eaſt*-point in the *Horizon*, and ſlide the upper end either *North* or *Southwards* on the *Meridian*, till the graduated Edge cut the Degree of the *Ecliptick* the *Sun* is in. Then I examine on the *Meridian*, what Degree the upper-end of the *Quadrant of Altitude* touches; which in this *Example*, I find is 28 Degrees: Therefore I ſubtract 28 from 51½ *London*'s *Latitude*, and there remains 23½. Then counting on the *Meridian* 23½ Degrees backwards, from the Point where the *Quadrant of Altitude* touched the *Meridian*, I come to 4 Degrees on the *Meridian*, *Northwards*. Therefore I ſay, in the *North Latitude* of 4 Degrees, and in the *Longitude* of *London* (which is about *C. Apolonia*, on the Coaſt of *Guinea*,) the *Sun* *May* 10. at 53 Min. paſt 8 a Clock in the Morning, hath the ſame *Altitude* above the *Horizon* it hath here at *London*.

The *Quadrant of Altitude* thus applied to the *Eaſt*-point of the *Horizon*, makes Right Angles with all Points on the *Meridian*, even as all the *Meridians* proceeding from the *Pole*, do with the *Equator*. Becauſe the *Eaſt*-point of *Horizon* is here made the Centre or *Pole* of the Plain of the *Meridian*: Therefore the *Quadrant* being applied both to the *Eaſt*-point and the *Suns* Place, projects a Line to interſect the *Meridian* in the Middle-point, between the *Latitude* of your Habitation, and the *Latitude* of that Place, in which the *Sun* ſhall have the ſame *Altitude* it hath at your Habitation at the ſame time. Thus it falls out, that thoſe that Inhabit 5 Deg. to the *Northwards* of this interſection, have the *Sun* the ſame Height that they have that Inhabit 5 Deg. to the Southwards of it: And thoſe 10, 20, 30 Deg. more or leſs, to the *Northwards*, have the *Sun* in the ſame Height that they have, that are 10, 20, 30. Deg. more or leſs,

to

to the *Southwards*: So that this Prob. may be done yet easier with your *Compasses*, thus: The *Globe* and *Hour-Index* Rectified; turn about the *Globe* till the *Hour-Index* point to the Hour of the Day: Then pitch one Foot of your Compasses in the *Suns* Place, and extend the other to the Degree of *Latitude* on the *Meridian*, which in this *Example*, is 51½ Degrees *North*; then keeping the first Foot of your *Compasses* on the Degree of the *Sun*, turn about the other Foot to the *Meridian*, and it will fall upon 4, as before.

By this Probleme you may take notice, how grosly they err, that think they can find the Height of the *Pole* at any Hour of the Day, by the *Suns* Height: Because they do not consider, that it is impossible to find the Hour of the Day, unless they first know the Height of the *Pole*.

## PROB. XLVIII.

### *To find the Length of the Longest and Shortest Artificial Day or Night.*

THE Artificial Day, is that space of Time which the *Sun* is above the *Horizon* of any Place; and the Artificial Night, is that space of Time which the *Sun* is under the *Horizon* of any Place. They are Measured in the *Hour-Circle*, by Hours and Minutes.

There is a constant and unequal disproportion in the Length of these Days and Nights; which is caused both by the Alteration of the *Suns Declination*, and the difference of the *Poles Elevation*.

Those that Inhabit on the *North*-side the *Equator*, have their Longest Day, when the *Sun* enters *Cancer*; and those that Inhabit on the *South*-side the *Equator*, have their Longest Day when the *Sun* enters *Capricorn*. But to know how long the Longest Day is in any *North* or *South* Elevation, raise the *North* or *South Pole*, according to the Elevation of the Place, and bring *Cancer* for *North* Elevation, or *Capricorn* for *South* Elevation, to the *Meridian*, and the *Index* of the *Hour-Circle* to 12. Then turn the *Globe* about, till *Cancer* for *North*, or *Capricorn* for *South* Elevation come to the *West*-side the *Horizon*, and the number of Hours and Minutes pointed at on the Hour-Circle doubled, is the number of Hours and Minutes of the Longest Day.

The Length of the Night to that Day, is found by Subtract-

tracting the Length of the Day from 24, for the Remainder is the length of the Night.

The ſhorteſt Day in that *Latitude*, is the length of the ſhorteſt Night, found as before. And the longeſt Night, is of the ſame length with the longeſt Day.

*Example.*

I would know the length of the longeſt Day at *London*. Therefore I Elevate the *North Pole* 51 ½ Degrees, and bring ♋ to the *Meridian*, and the *Index* of the *Hour-Circle* to 12. Then I turn ♋ to the *Weſtern*-ſide the *Horizon*, and find the *Index* point at 8 Hours 18 Minutes; which being Doubled, makes 16 Hours 36 Minutes, for the length of the longeſt Day here at *London*.

## PROB. XLIX.

*To find how much the* Pole *is* Raiſed *or* Depreſſed, *where the Longeſt Day is an Hour Longer or Shorter than it is in your Habitation.*

REctifie the *Globe* to the *Latitude* of your Place, and make a Prick at that Point of the *Troprick*, which is at the *Meridian*; I mean at the *Troprick* of *Cancer*, if your Habitation be on the *North*-ſide the *Equator*, or ♑ if your Habitation be on the *South*-ſide the *Equator*. And if you would know where the longeſt Day is juſt an Hour longer than it is at your Habitation, turn the *Globe* to the *Weſtward*, till 7 ½ Degrees of the *Equator* paſs through the *Meridian*, and make there another Prick on the *Troprick*; then turn about the *Globe* till the firſt Prick come to the *Horizon*; and move the *Meridian* through the Notches of the *Horizon*, till the ſecond Prick on the *Troprick* come to the *Horizon*; ſo ſhall the Arch of the *Meridian*, contained between the Elevation of your Place, and the Degree of the *Meridian* at the *Horizon*, be the number of Degrees that the *Pole* is Elevated Higher than it is in your *Latitude*.

*Example.*

I would know in what *Latitude*, the longeſt Day is an Hour longer than it is at *London*. Therefore, I Rectifie the *Globe* to 5½ Deg. and where the *Meridian* cuts the *Troprick* of ♋ I make a Prick

Ben

a Prick; then I note what degree of the *Equator* is at the *Meridian*, and from that degree on the *Equator* count $7\frac{1}{2}$ degrees to the Eastwards, and bring those $7\frac{1}{2}$ degrees to the *Meridian* also; and again, where the *Meridian* cuts the *Tropick* of ♋ I make no other Prick, so shall $7\frac{1}{2}$ degrees of the *Tropick* be contained between those two Pricks: Then I turn the *Globe* about, till the First Prick comes to the *Horizon*, and (with a Quill, thrust between the *Meridian* and the Ball) I fasten the *Globe* in this Position: Afterwards I move the *Meridian* through the Notches of the *Horizon*, till the Second Prick Rises up to the *Horizon*, and then I find $56\frac{1}{2}$ degrees of the *Meridian* cut by the Superficies of the *Horizon*: Therefore I say, in the *Latitude* of $56\frac{1}{2}$ degrees, the longest day is an Hour longer than it is here at *London*.

But if you would know in what Latitude the days are an Hour Shorter, you must make your Second Prick $7\frac{1}{2}$ degrees to the *Westwards* of the First, and after you have brought the First Prick to the *Horizon*, you must depress the Pole, till the Second Prick descends to the *Horizon*; so shall the degree of of the *Meridian* at the *Horizon*, shew in what Elevation of the *Pole* the days shall be an Hour shorter.

By this Probleme may be found the Alteration of Climates: For (as was said in the definition of *Climates*, *Book* 1. *Fol.* 28.) Climates alter according to the Half-Hourly increasing of the longest day; therefore the Latitude of $56\frac{1}{2}$ degrees (having its days increased an whole Hour) is distant from the Latitude of *London*, by the Space of two Climates.

## PROB. L.

*The* Suns *Place given, to find what Alteration of* Declination *it must have, to make the Day an Hour Longer or Shorter; and in what Number of Days it will be.*

REctifie the *Globe* to the Latitude of the Place, and bring the *Sun*'s Place to the East side the *Horizon*, and note against what degree of the *Horizon* it is: Then bring one of the *Colures* to intersect the *Horizon* in that degree of the *Horizon*, and at the Point of Intersection make a Prick in the *Colure*; and observe what degree of the *Equator* is then at the *Meridian*; Then turn the *Globe* Westwards, if the days shorten, but Eastwards, if

they Lengthen till 7 ½ Degrees of the *Equator* pass through the *Meridian*, and where the *Horizon* intersects the same *Colure*, make another Prick in the *Colure*: Afterwards bring the *Colure* to the *Meridian*, and count the number of Degrees between the two Pricks; for so many Degrees must the *Suns Declination* Alter, to Lengthen or Shorten the Day and Hour.

*Example.*

The *Suns* Place is ♉ 10. I would know how much he must alter his *Declination* before the Day is an Hour longer here at *London*. Therefore I Rectifie the *Globe* to the *Latitude* of *Lond.* and bring ♉ 10. to the *East*-side the Horizon, and find it against 24 ½ Degrees from the *East*-point: Therefore I bring one of the *Colures* to this 24 ½ Degrees, and close by the Edge of the *Horizon*; I make a Prick with Black Lead, in the *Colure*: Then keeping the *Globe* in this Position, I look what Deg. of the *Equator* is then at the *Meridian*, and find 250. 15. And because the Days Lengthen, I turn the *Globe Eastwards*, till 7 ½ Degrees from the aforesaid 250. 15. pass through the *Meridian*: Then keeping the *Globe* in this Position, I make another Prick in the *Colure*; and bringing this *Colure* to the *Meridian*, I find a little more than 5 deg. of the *Meridian*, contained between the two Pricks: Therefore, I say, when the *Sun* is in ♉ 10 degrees, he must alter his *Declination* a little more than 5 degrees, to make the Day an Hour Longer.

Now to know in what number of Days he shall alter this *Declination*, you must find the *Declination* of the two Pricks on the *Colure*, as you found the *Suns Declination* by Prob. 5. and the Arch of the *Ecliptick* that passes through the *Meridian*, while the *Globe* is turned from the First Pricks *Declination* to the Second Pricks *Declination*, is the number of the *Ecliptical* degrees that the *Sun* is to pass, while he alters this *Declination*, and the deg. of the *Ecliptick* then at the *Meridian*, is (with respect had to the Quarter of the Year,) the Place the *Sun* shall have when its *Declination* shall be altered, so much as to make the Day an Hour Longer.

Thus having the *Suns* first Place given, and its Second Place found, you may by finding those two Places on the Plain of the *Horizon*, also find the number of Days comprehended between them, as you are taught by the fourth Probleme.

This

This Probleme thus wrought for different Times of the Year, will shew the Fallacy of that Vulgar Rule, which makes the Day to be Lengthned or Shortned an Hour in every Fifteen Days; when as the Lengthning or Shortning of Days keep no such Equality of Proportion: For when the *Sun* is near the *Equinoctial* Points, the Days Lengthen or Shorten very fast; but when he is near the *Tropical* Points, very slowly.

## PROB. LI.

*Of the Difference of* Civil *and* Natural Days, *commonly called the* Equation *of* Civil Days. *And how it may be found by the* Globe.

THE *Civil Day*, is that space of Time containing just 24 Hours, reckoned from 12 a Clock on one Day to 12 a Clock the next Day; in which space of Time, the *Equinoctial* makes upon the *Poles* of the *World* a Diurnal Revolution. The *Natural Day*, is that space of Time wherein the *Sun* moveth from the *Meridian* of any Place to the same *Meridian* again. These Days are at one Time of the Year Longer than at another; and at all times Longer than the *Civil Days*. There is but small discrepancy between them, yet some there is, made by a twofold Cause. For First, The *Suns* Apparent Motion is different from his true Motion; He being much Slower in his *Apogeum*, than he is in his *Perigeum*: For when the *Sun* is in his *Apogeum*, he scarce Moves 58 Minutes from *West* to *East* in a *Civil Day*, but when he is in his *Perigeum*, he moves above 61 Minutes in a *Civil Day*: And therefore increases his *Right Ascension* more in equal Time.

The Second Cause is the difference of *Right Ascension* answerable to equal Parts of the *Ecliptick*: for about ♋ and ♑ the differences of *Right Ascensions* are far greater than about ♈ and ♎; for about ♈ and ♎ the *Right Ascension* of 10 deg. is but 9 Degrees 11 Minutes; but about ♋ and ♑, the *Right Ascension* of 10 Degrees, will be found to be 10 Degrees 53 Minutes; as by the *Globe* will appear.

But because of the smallness of the *Globes* Graduation, you cannot actually distinguish to Parts near enough for the Solution of this Probleme, if you would enquire the difference in Length of two single Days; therefore it will be requisite to take some

ber of Days together; suppose 20. Therefore find by *Prob.* 3. the Places of the *Sun*, from the beginning and ending of those Days you would compare; and find the *Right Ascension* answerable to each Place in the *Ecliptick*; and also the Differences of *Right Ascensions*, answerable to the *Sun*'s Motion, in each number of Days: Then compare the Differences of *Right Ascensions* together; and by Subtracting the Lesser from the Greater, you will have the number of Degrees and Minutes of the *Equator*, that have passed thro' the *Meridian*, more in one number of Days, than in the other number of Days: Which degrees of the *Equator* converted into *Time*, is the number of Minutes, that the one number of days is longer than the other number of days.

*Example.*

I would know what difference of Time there is in the Length of the first 20 days of *December*, and the first 20 days of *March*. I find by *Prob.* 3. the *Sun*'s Place, *December* 1. is ♐ 19.45. at the end of 20 days, *viz.* on the 21 day his Place is ♑ 10.11. The *Sun*'s Place, *March* 1. is ♓ 21.16, at the 20 days end, *viz. March* 21. his Place is ♈ 11.3.

I find by *Prob.* 26. the *Right Ascension* answerable to ♐ 19.45, ♑ 10.11, ♓ 21.16, ♈ 11. 3 is 258.10. 280.25. 352.00. 9.40.

and the difference of *Right Ascensions* contained between the first day in each Month, and the 21 of the same Month, by Subtracting the Lesser from the Greater is, for

| | | | |
|---|---|---|---|
| 258.10. | | | 352.00. |
| 280.25. | | And for | 9.40. |
| 22.15. | | | 17.40. |

But note, because the *Vernal Colure* (where the degrees of *Right Ascension* begin and end their Account) is intercepted in the Arch of the *Sun*'s Motion, from the first to the 21 of *March*. Therefore instead of Subtracting the lesser number of degrees of *Right Ascension* from the Greater, *viz.* 9.40. from 352. I do for finding the difference of the *Ascensional Arch* of the *Sun*'s Motion in those 20 days, Subtract the aforesaid 352. degrees from 360. and the Remains is 8. which is the difference of *Right Ascension* from ♓ 21.16. to the *Equinoctial Colure*: To which 8, adding

adding 9 Degrees 40 Minutes, the *Right Ascension* from the *Equinoctial Colure*, to ♈ 11.3. it makes 17 Degrees 40 Minutes for the Difference of *Right Ascensions* between ♑ 21.16. and ♈ 11.3. Then I find the Difference of this Difference of *Right Ascension*, by Subtracting the Less from the Greater, *viz.* 17.40. from 22.15. and the Remains is 4 Degrees 35 Minutes, for the number of Degrees and Minutes of the *Equator*, that pass thro the *Meridian* in the first 20 Days, in the Month of *December*, more than in the first 20 Days of the Month of *March*, which 4 Degrees 35 Minutes, converted into *Time*, gives 19 Minutes, that is, a Quarter of an Hour, and 4 Minutes, that the first 20 Days of *December* aforesaid, are longer than the first 20 Days of *March*.

## PROB. LII.

### *How to find the Hour of the Night, when the* Moon *Shines on a* Sun-Dial, *by help of the* Globe.

REctifie the *Globe*, and find by *Prob.* 54. or an *Ephemeris*, the Moons Place at Noon: Bring it to the *Meridian*, and the *Index* of the *Hour-Circle* to 12, and turn about the *Globe*, till the *Index* of the *Hour-Circle* points to the same Hour, the Shade of the Moon falls on the *Sun-Dial*. Then by *Prob.* 3. find the *Sun*'s Place at Noon, and see how many Degrees of *Right Ascension* are contained between the *Sun*'s Place, and the degree of the *Equator* at the *Meridian*, when the *Index* of the *Hour Circle* is brought to the Hour the Moon Shines on in the *Sun-Dial*; for those number of Degrees, converted into Time, shall be the Time from Noon, or the Hour of the Night. Only note, Respect must be had to the Motion of the Moon, from *West* to *East*; for so Swift is her Mean Motion, that it is accounted to be above 12 Degrees in 24 Hours; that is, 6 Degrees in 12 Hours, 3 Deg. in 6 Hours, *&c.* and this also converted into Time, as aforesaid, you must add proportionably to the Time found from Noon; and the Sum shall give you the true Hour of the Night.

### *Example.*

Here at *London* I desire to know the Hour of the Night, *January* 6. this present Year 1658. The *Moons* Place found by an

an *Ephemeris*, or for want of an *Ephemeris*, by Prob. 54. is in ♊ 21 Degrees 22 Minutes; therefore I rectified the *Globe* to *London*'s *Latitude*, and brought ♊ 21. 22. Minutes to the *Meridian*, and the *Index* of the *Hour-Circle* to 12. then by Prob. 3. I found the *Suns* Place in ♍ 26 Degrees 46 Minutes, and by Prob. 26. I found his *Right Aſcenſion* to be 300 Degrees; then I turned about the *Globe* till the *Index* of the *Hour-Circle* pointed at 10 Hours, and at the Degree of the *Equator* at the *Meridian*, I made a Prick; then I accounted the number of Degrees of the *Equator*, contained between the foreſaid 300 Deg. and this Prick, and found them 111¼ Degrees, which converted into *Time*, by allowing 15 Degrees for an Hour, give 7 Hours 25 Minutes Time for Noon: which if the *Moons* Motion were not to be conſidered, ſhould be the immediate Hour of the Night: But by the Rule aforeſaid, the *Moons* Motion from *Weſt* to *Eaſt*, in 7 Hours 25 Minutes, is 3 Degrees 42 Minutes: And this 3 Degrees 42 Minutes being converted into *Time*, is 14 *Minutes* more, which being added to 7 Hours 25 Minutes, make 7 Hours 39 Minutes, for the true Hour of the Night.

## PROB. LIII.

### *To find the* Dominical Letter, *the* Prime Epact, Eaſter Day, *and the reſt of the* Moveable Feaſts, *for ever.*

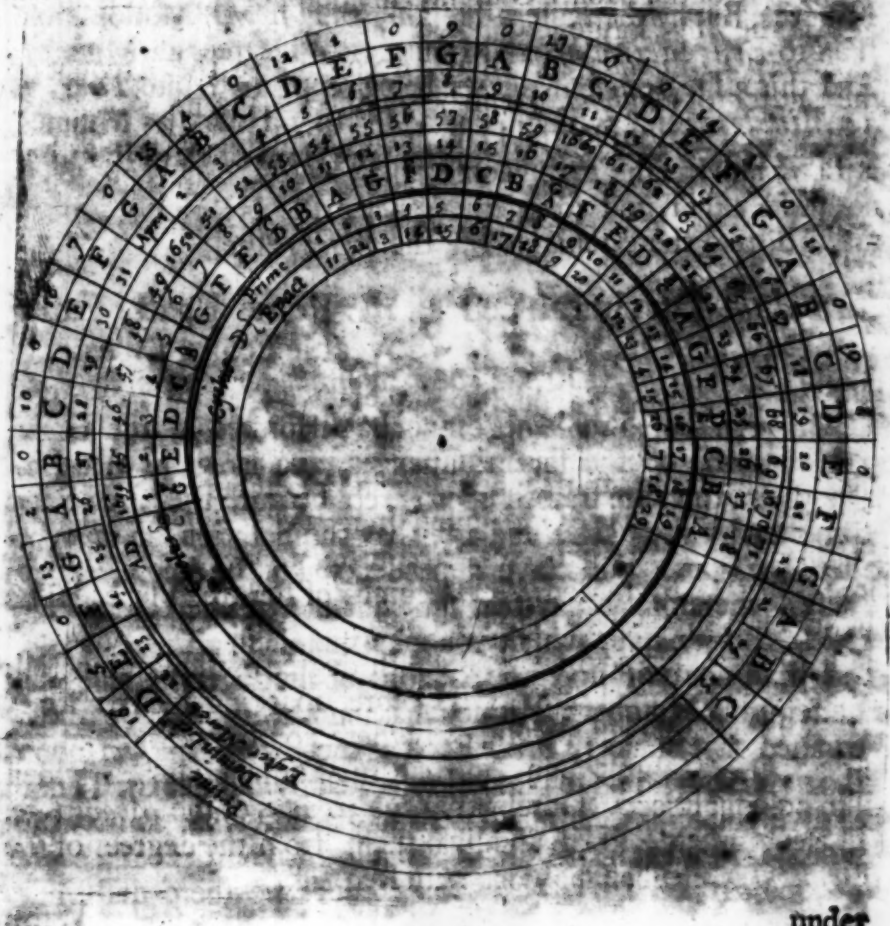
THough theſe Problemes cannot be performed by the *Globe*, becauſe of the ſeveral Changes, and irregular Accounts that their Rules are framed upon; yet, becauſe they are of frequent and Vulgar Uſe, and for that the Solution of many other Queſtions, will have dependency on the knowledge of theſe, therefore I have thought fit here to inſert this *Table* of Mr. *Palmer*'s, by which you may find them all.

I ſhall not inſiſt upon the Reaſons of the ſeveral Changes of Letters, and Numbers, Himſelf having already very learnedly handled that Subject, in his Book of the *Catholick Planiſphere*, *Book* 1. *Chapter* 11. (to which I refer you;) neither ſhall I need to give you any other Inſtructions for finding what is here propoſed, than what himſelf hath given in his Fourth *Book*, *Chapter* 66, and part of 67. therefore take it as he there delivers it.

An

An *Example* shall serve here instead of a *Rule*. For the Year 1657. I would know all these: Wherefore I seek the Year 1657. in the Table of the *Suns Cycle*, and over against it, find 14 for the Year of the *Cycle of the Sun*, and D for the *Dominical Letter*. And note here, that every *Leap-Year* hath 2 *Dominical Letters* (as 1660 hath A G) and the First (*viz.* A) serveth that Year till *February* 25, and the Second (G) for the rest of the Year. And note, that these Letters go always backwards, when when you count forwards (as B A, then G F, *&c.* not F G, and then A B,) as you may see by the Table.

Then in the Table of the *Cycle of the Moon*, I have for the Year 1657. the *Prime* 5. the *Epact* 25. Those had, I go to the Table for *Easter*, and seek there in the first Rank the *Prime* 5, and



under

under it in the middle Rank ſtands B, that is not my Dominical Letter, therefore I ſeek not backward, but always forward in the middle Rank, till I come to my Dominical Letter D, and under it I find in the third Rank, *March* 29. upon which *Eaſter-Day* falls this Year 1657. The reſt of the *Moveable Feaſts* may be had by their diſtances from *Eaſter*, which are always the ſame. Only for *Advent-Sunday* remember, that the next *Sunday* after *November* 26. is *Advent-Sunday*. Read *Book* I. II. and that will ſufficiently inſtruct you with this *Example*.

### *To find the Age of the* Moon.

Remember firſt, that the Epact begins with *March*, which muſt be here accounted the firſt Month: Then if you add to the Epact the number of the Month Current, and the number of the Day of the Month Current, the Sum, or the Exceſs above 30, is the *Moons* Age.

*Example*, *January* 20. 1656. According to the Account of the Church of *England*, (who begin the Year with *March* 25. which was the Equinoctial Day about Chriſt's Time) the Epact is 14. *January*, is the 11th Month, and the 20th Day is propoſed; now add 14, 11, and 20 together, they make 45, out of which I take 30, and there remains 15, the *Moons* Age.

## PROB. LIV.

### *The Age of the* Moon, *given to find her Place in the* Ecliptick, *according to her* Mean Motion.

THIS Probleme may be performed exact enough for common Uſes by the *Globe*, but in regard it only ſhews the *Moons* Place in the Ecliptick, according to her Mean Motion, it will often fail you ſome few degrees of her true Place. The Work is thus;

Firſt ſet Figures to every Twelfth degree of the Equinoctial, accounted from the Equinoctial Colure, marking them with 1, 2, 3, 4, *&c.* to 30. which will end where you began, *viz.* at the Equinoctial Colure again; ſo ſhall the Equinoctial be divided into 30 equal Parts, repreſenting the 30 days of the *Moons* Age. Theſe Figures (to diſtinguiſh them from the degrees of the *Equator*) were beſt be writ with Red Ink.

When

When you would enquire the *Moons* Place, Elevate the *North Pole* 90 Degrees, that is, in the *Zenith*, ſo ſhall the *Equator* lye in the *Horizon*: Then bring the *Equinoctial Colure* againſt the Day of the Month in the *Horizon*, ſo ſhall the *Moons* Age written in Red Figures, ſtand againſt the Sign and Degree in the *Horizon* that the *Moon* is in at that Time.

*Example.*

*September* 28. 1658. I would know the *Moons* Place in the *Ecliptick*, She being then 12 Days Old. Therefore I Elevate the *North Pole* 90 Degrees above the *Horizon*, and turn the *Globe* about till the *Equinoctial Colure* come to *September* 28. in the Circle of Days on the *Horizon*; then looking againſt what *Sign* and Degree of the *Ecliptick* Circle in the *Horizon* the 12th diviſion in Red Figures ſtands, I find ♓ 9. which is the *Sign* and Degree the *Moon* is in, according to her *Mean Motion*.

This Probleme may be applied to many Uſes: For having the *Moons* Place, you may find the Time of her *Riſing*, *Southing*, *Setting*, and *Shining*, &c. by working with Her, as you were taught to work with the *Sun*, in ſeveral foregoing Problemes, proper to each purpoſe.

## PROB. LV.

*Having the* Longitude *and* Latitude, *or* Right Aſcenſion *and* Declination *of any* Planet, *or* Comet, *to place it on the* Globe, *to correſpond with its place in* Heaven.

PLanets and *Comets* cannot be placed on the *Globe* ſo as their Places will long retain correſpondence with their Places in *Heaven*; Becauſe, as was ſaid, Chap. 44. they have a continual Motion from *Weſt* to *Eaſt* upon the *Poles* of the *Ecliptick*: Yet nevertheleſs, you may, by having their *Longitude* and *Latitude*, or *Right Aſcenſion* and *Declination*, for any ſet Time, place a Mark for them on the *Globe*, either with Ink, if your *Globe* be Varniſht, for then you may with a wet Finger wipe it off again; or with Black-lead, if it be not Varniſht, and then you may rub it out again with a little White

Bread: Which Mark for that Time, will as effectually ſerve you to work by, as any of the Fixed *Stars* placed on the *Globe* will do.

Therefore if the *Longitude* and *Latitude* of any *Planet* or *Comet* be given; do thus, Elevate the *North Pole* if the *Latitude* given be *North*; but if the *Latitude* given be *South*, Elevate the *South Pole*, 66½ Degrees; and place the *Pole* of the *Ecliptick* in the *Zenith*, and over it ſcrew the *Quadrant of Altitude*: So ſhall the *Ecliptick* lye in the *Horizon*; and the *Quadrant of Altitude* being turned about the *Horizon*, ſhall paſs through all the Degrees of *Longitude*; Then find the point of given *Longitude* in the *Ecliptick*, and bring it to the *Quadrant of Altitude*, and hold it there: Then count upwards on the *Quadrant of Altitude*, the number of Degrees and Minutes of Given *Latitude*, and at the point where the number ends cloſe to the *Quadrant of Altitude*, make a ſmall Prick, and that Prick ſhall repreſent the *Planet* or *Comet* you were to place on the *Globe*.

If it be the *Right Aſcenſion* and *Declination* of a *Planet* or *Comet* that is given; you muſt find the Degree and Minute of *Right Aſcenſion* on the *Equinoctial*, and bring it to the *Meridian*, and keep the *Globe* there ſteddy; then find the Degree and Minute of *Declination* on the *Meridian*, and under that Degree and Minute on the *Globe*, make a Prick, and that Prick ſhall repreſent the *Planet* or *Comet*, as aforeſaid.

If it be ♄ or ♃ that this Prick is to repreſent, it may ſtand on the *Globe* ſometimes a Week or a Fortnight, without much difference from the *Planets* place in Heaven. But if the Prick were to repreſent the other *Planets*, you muſt (in regard of their Swift Motion) alter it very often, eſpecially for the *Moon*; for ſo Swift is her Motion, that in every Two Hours ſhe Alters about a Degree in *Longitude*.

Having thus placed this Mark on the *Globe*, you may find out the Time of its ſeveral Poſitions and Aſpects, if you work by it as you are directed to work by the *Sun*, in the ſeveral reſpective Problemes throughout this Book.

*The End of the Second Book.*

The

# The Third BOOK.

Being the Practical Uſe of the

# GLOBES.

Applied to the Solution of *PROBLEMES*

IN THE

# Art of Navigation.

## PRÆFACE.

BEcauſe *the Art of* Navigation *conſiſts as well in the knowledge of* Aſtronomical *and* Geographical Problemes, *as in Problemes meerly* Nautical; *Therefore I muſt deſire the Artiſt to ſeek in the laſt Book ſuch Problemes as are only* Aſtronomical *or* Geographical: *For my Deſign is here to collect ſuch Problemes as are only uſed in the Art of* Navigation: *Some few particulars excepted, as for finding* Latitude, Longitude, Courſe, Diſtance, *&c. Which though they are handled in that Book; yet for their Utility in the Art of* Navigation, *and for that what there is Given, cannot always be had to Work by; therefore in this Book I have mention'd divers other* Obſervations, *which being Made or Had, you may by the Rules proper for each* Obſervation, *Find what ſhall be Propoſed.*

## PROB. I.

*The* Suns Amplitude *and* Difference *of* Ascension *given, to find the* Height *of the* Pole, *and* Declination *of the* Sun.

ELevate the *Pole* so many Degrees as the Difference of the *Suns Ascension* is, and screw the *Quadrant of Altitude* to the *Zenith*, and bring the first point of ♈ to the *Meridian*; then number on the *Quadrant of Altitude* upwards the Complement to 90 of the *Suns Amplitude*, and move the *Quadrant of Altitude* till that number of Degrees cuts the *Equator*; So shall the *Quadrant* cut in the *Horizon* the Degree of the *Poles Elevation*; and in the *Equator* the Degree of the *Suns Declination*.

*Example.*

The Difference of *Ascension* is 27 Degrees 7 Minutes. Therefore I Elevate the Pole 27 Degrees 7 Minutes Above the *Horizon*, and screw the *Quadrant of Altitude* to 27 Degrees 7 Minutes, which is in the *Zenith*: Then I bring the first point of ♈ to the *Meridian*, and number on the *Quadrant of Altitude* upwards 56 Degrees 40 Minutes, the Complement of the *Suns Amplitude*, and bring that Degree to the *Equator*: Then I see in what Degree of the *Horizon* the *Quadrant* cuts the *Horizon*, and find 51½, which is the *Elevation* of the *Pole*: Then looking in what Degree of the *Equator* the *Quadrant of Altitude* cuts the *Equator*, I find 20 Degrees 5 Minutes, which is the *Declination* of the *Sun* at the same Time.

## PROB. II.

*The* Suns Declination *and* Amplitude *given, to find the* Poles Elevation.

ELevate the Pole so many Degrees as the Complement of the *Suns Altitude* is; and screw the *Quadrant of Altitude* in

in the *Zenith*, and bring the first point of ♈ to the *Meridian*: Then count on the *Quadrant of Altitude* to the Degree of the *Suns Declination*, and bring that Degree to the *Equinoctial*; and the Degree of the *Equinoctial*, cut by that Degree of the *Quadrant of Altitude*, is the Degree of the *Poles Elevation*.

*Example.*

The *Suns Amplitude* is 33 Degrees 20 Minutes, his *Declination* is 20 Degrees 5 Minutes, his Complement of *Amplitude* to 90 is 56 Degrees 7 Minutes. Therefore I Elevate the *Pole* 56 Degrees 7 Minutes Above the *Horizon*, and screw the *Quadrant of Altitude* to 56 Degrees 7 Minutes, which is in the *Zenith*: Then I bring the first point of ♈ to the *Meridian*, and number on the *Quadrant of Altitude* Upward 20 Degrees 5 Minutes for the *Suns Declination*, this 20 Degrees 5 Minutes, I bring to the *Equinoctial*, and find it cut there 51½ Degrees, for the *Height* of the *Pole*.

## PROB. III.

*The* Suns Declination *and* Hour *at* East *given, to find the* Height *of the* Pole.

ELevate the *Pole* so many Degrees as the *Suns Declination* is, and screw the *Quadrant of Altitude* in the *Zenith*: Then Convert the Hours or Minutes past 6 given into Degrees, by allowing 15 Degrees for every Hour of *Time*, and for every Minute of *Time* 15 Minutes of a Degree; and number those Degrees or Minutes in the *Horizon* from the *East Southwards*; and bring the *Quadrant of Altitude* to that Degree, so shall the Degree of the *Quadrant of Altitude* cut by the *Equator*, be the Complement of the *Height of the Pole*.

*Example.*

The *Suns Declination* is 20 Degrees 5 Minutes; therefore I Elevate the *Pole* 20 Degrees 5 Minutes, and also screw the *Quadrant of Altitude* to 20 Degr. 5 Min. which is in the *Zenith*: The Hour the *Sun* comes to be at *East* is 7 a Clock 7 Minutes, that is, 1 Hour 7 Minutes after 6. Therefore I convert 1 Hour 7 Minutes

nutes into Degrees, as before, and it gives 16 Degrees 50 Minutes; which number of Degrees and Minutes I count from the *East* point *Southwards*, and thither I bring the *Quadrant of Altitude*: Then I look in what Degree of the *Quadrant of Altitude* the *Equator* cuts, and find $38\frac{1}{2}$, which is the *Complement of the Pole Height*, *viz* $51\frac{1}{2}$ Degrees for the *Height of the Pole*.

In this Probleme, the *Declination* of the *Sun*, and Elevation of the *Pole*, bears the same Denomination of either *North* or *South*, for when the *Declination* and the Elevation are Different, the *Sun* cannot come to the *East* point.

## PROB. IV.

*The* Declination *of the* Sun, *and his* Altitude *at* East *given, to find the* Height *of the* Pole.

ELevate the *Pole* to the Complement of the *Suns Altitude*, and screw the *Quadrant of Altitude* to the *Zenith*: Then bring the *Equinoctial* point ♈ to the *Meridian*, and number on the *Quadrant of Altitude* the Degree of the *Suns Declination*, and bring that Degree to the *Equinoctial*, and note the Degree it Cuts; for its Complement to 90 is the *Height of the Pole*.

### *Example.*

*May* 10. The *Suns Declinaion* is 20 Degrees 5 Minutes; His *Altitude* at *East* is 25 Degrees 55 Minutes here at *London*: I enquire the *Height of the Pole*. Therefore I subtract 25 Deg. 55 Min. from 90, the Remains is 64 Deg. 5 Min. for its Complement, wherefore I bring 64 Deg. 5 Min. of the *Meridian* to the *Horizon*; and to 64 Deg. 5 Min. which is the *Zenith*, I screw the *Quadrant of Altitude*: Then I bring ♈ to the *Meridian*, and count on the *Quadrant of Altitude* upwards 20 Deg. 5 Min. and move it about the *Equinoctial* till those 20 Deg. 5 Min. touch the *Equinoctial*, which I find to be in $38\frac{1}{2}$ Degrees, Therefore I Subtract those $38\frac{1}{2}$ from 90, and the Remains is $51\frac{1}{2}$ Degrees. Therefore I say the *Pole* here at *London* is Elevated $51\frac{1}{2}$ Degrees.

The *Declination* and the Elevation is always of the same Denomination *North* or *South*, for when they Alter their Denominations, the *Sun* at *East* can have no *Altitude*, neither can it indeed reach

reach the *East* point: And therefore in this *Example*, becauſe the *Suns Declination* is *North*, it is the *North Pole* that is Elevated.

*To perform the ſame otherwiſe, with a pair of* Compaſſes.

Take off with your *Compaſſes* from the *Equator* or *Quadrant of Altitude*, the number of Degrees of *Altitude* Obſerved, and place one Foot at the beginning of ♈ on the inner edge of the *Horizon*, and extend the other directly Upwards towards the *Zenith*: Then move the *Brazen Meridian* through the Notches of the *Horizon*, till the other point of your *Compaſſes* (reſpecting the *Zenith*) reach the Parallel of the *Suns Declnation*: So ſhall the number of Degrees on the *Meridian*, be the number of Degrees that the *Pole* is Elevated above the *Horizon*; and is either *North* or *South*, according as the *Suns Declination* is: As before.

This may yet otherwiſe be performed with the *Quadrant of Altitude*, by taking the *Nut* off the *Meridian*, and laying the edge of its *Index* (ſpecified in Cap. 1. Sect. 6. of the firſt Book) exactly on the *Eaſt* Line of the *Horizon*: For when that lies ſtraight between the point of *Eaſt*, on the outer verge of the *Horizon*, and the beginning of ♈ in the inner verge of the *Horizon*, then ſhall the upper end of the *Quadrant of Altitude* point directly to the *Zenith*: And if then you turn the *Meridian* through the Notches of the *Horizon*, till the *Suns Altitude* on the *Quadrant of Altitude* Cuts the Parallel of *Declination*, you will have the end of the *Quadrant of Altitude* on the *Meridian* point to the Height of the *Pole*: As before.

## PROB. V.

*By the* Suns Declination *and* Azimuth *at 6 of the Clock given, to find the Height of the* Pole, *and* Almicantar *at ſix.*

ELevate the *Pole* ſo many Degrees as the *Suns Azimuth* is at 6. and ſcrew the *Quadrant of Altitude* in the *Zenith*, and bring the firſt point of *Aries* to the *Meridian*: Then number on the *Quadrant of Altitude* Upwards the Complement of the *Suns Declination*, and bring that Degree to the *Equator*: So ſhall the Degree

degree of the *Horizon* cut by the *Quadrant of Altitude*, be the Complement of the *Poles Elevation*; and the degree of the *Equator* cut by the *Quadrant of Altitude*, shall be the *Almicantar* of the *Sun* at 6 of the Clock.

*Example.*

The *Suns Azimuth* at 6 is 12¾ degrees: Therefore I Elevate the *Pole* 12¾, and screw the *Quadrant of Altitude* to 12¾ degrees, which is in the *Zenith*: Then I bring the first point of ♈ to the *Meridian*; the *Suns Declination* is 20 deg. 5 Min. Therefore I number on the *Quadrant of Altitude* 69 deg. 55 Min. which is the Complement of 20 deg. 5 Min. to 90. this 69 deg. 55 Min. on the *Quadrant of Altitude* I bring to Cut the *Equator*, and find when 69 Deg. 55 Min. cuts the *Equator*, that the *Quadrant of Altitude* Cuts the *Horizon* in 38½ deg. which is the Complement of the *Poles Elevation*: And at the same time, the *Quadrant of Altitude* also Cuts the *Equator* in 15½ degrees; which is the *Almicantar* or *Altitude* of the *Sun* at 6 a Clock.

## PROB. VI.

*The* Day *of the* Month *and* Hour *of the* Night *given, to find the* Height *of the* Pole, *by a known* Star *Observed* Rising *or* Setting.

REctifie the *Hour Index*, by Prob. 2. of the former Book; and turn the *Globe Westwards* till the *Hour Index* points at the Hour of the Night; fasten the *Globe* there, and turn the *Meridian* through the Notches of the *Horizon*, till the known *Star* come to the *East-side* the *Horizon*, if the *Star* be Rising, or the West, if it be Setting; so shall the degrees of the *Poles Elevation* be Cut by the *Horizon* under the Elevated *Pole*; and is North or *South* according as the Elevated *Pole* of the *Globe* is.

## PROB. VII.

*Two* Places *given in the same* Latitude, *to find the* Difference *of* Longitude.

BRing the first Place to the *Meridian*, and note the number of degrees of the *Equinoctial* that comes to the *Meridian* with

with it; then bring the other Place to the *Meridian*, and note the number of degrees of the *Equator* that comes to the *Meridian* with it: And by Subtracting the Leſſer number from the greater you have the difference of *Longitude*. This needs no *Example*.

## PROB. VIII.

*Two places given in the ſame* Longitude, *to find the Difference of* Latitude.

BRing the places to the *Meridian*, and the degrees of the *Meridian* over the two Places, is the *Latitudes* of them both: And by ſubtracting the Leſſer number of degrees from the Greater, you will have the difference of *Latitude*.

## PROB. IX.

Courſe *and* Diſtance *between two* Places *given, to find their Difference in* Longitude *and* Latitude.

SEEK the *Rhumb* you have Sailed upon, as in Prob 34. of the laſt Book, and upon that *Rhumb* make a Mark for the Place you departed from; then with your *Compaſſes* take off from the *Equinoctial* the number of *Leagues* you have Sailed upon that *Rhumb*, by allowing a degree for every 20 *Leagues*, and place one Foot of your *Compaſſes* upon that Mark, and where the other Foot falls on that *Rhumb*, make a Second Mark; then by bringing the Firſt Mark to the *Meridian*, you will ſee on the *Meridian* the *Latitude* of that Mark, and in the *Equator* the *Longitude*, as in Prob. 2. of the laſt Book: And by bringing the Second Mark alſo to the *Meridian*, you will, as before, find the *Longitude* and *Latitude* of the Second Mark alſo. Then by Subtracting the Leſſer *Latitude* from the Greater *Latitude*, and the Leſſer *Longitude* from the Greater *Longitude*, you will have the difference remaining, both of *Longitude* and *Latitude* you are arrived into.

## PROB. X.

*To find how many* Miles *are contained in a* Degree *of any* Parallel.

EVery degree of the *Equinoctial* contains 20 *English Leagues*, and every League 3 *English Miles*: But in every *Parallel* to the *Equinoctial*, the degrees diminish more and more, even to the *Pole*, where they end in a point. Therefore a degree in any *Parallel* cannot contain so many *Miles* as a Degree in the *Equinoctial*. Now that you may know how many *Miles* are contained in a degree of any *Parallel* to the *Equinoctial*, do thus, Measure with your *Compasses* the Width of any number of degrees in any given *Parallel*; suppose (for *Example* sake) 10 degrees in the *Parallel* of 51½; Examine in the *Equator* how many degrees of the *Equator* they will make, and you will find 6½. Therefore 1 deg. in the *Equator* making 60 *Miles*, 6 degrees makes 360, to which Add for the ½ part 12 *Miles*, makes 372 *Miles*, to be the Measure of 10 degrees in the *Parallel* of 51½. So that by dividing 372 by 10, you have 37 *Miles* for the Length of a degree, from *East* to *West* in the *Parallel* of 51½ degrees.

## PROB. XI.

*The* Rhumb *you have* Sailed *upon, and the* Latitudes *you* departed *from, and are* arrived *to, given, to find the* Difference *of* Longitude, *and the number of* Leagues *you have* Sailed.

FIrst seek the *Rhumb* you have Sailed on, and pass it through the *Meridian* till it Cuts in the *Meridian* the *Latitude* you departed from; and keeping the *Globe* there steddy, make a Mark close by the *Meridian*, under that *Latitude*, and in that *Rhumb* on the *Globe*, and note in the *Equinoctial* the degree of *Longitude* at the *Meridian*: Then pass that *Rhumb* through the *Meridian* again, till it Cuts in the *Meridian* the *Latitude* you are Arrived to; and in that *Rhumb* and *Latitude* make on the *Globe* another Mark, and examine in the *Equinoctial* the

the *Longitude* of the Second Mark; for the difference between First and Second Mark, is the difference of *Longitude*; Then open your *Compasses* to one degree of the *Equinoctial*, and by measuring along in the *Rhumb*, Count how many times that distance is contained between the two Points in that *Rhumb*, for so many times 20 *Leagues* is the distance you have Sailed.

*Example.*

I Sail upon the *North-West Rhumb*, from the *Latitude* of 10 degrees, into the *Latitude* of 30 degrees 40 Minutes. Therefore I find the *North-West Rhumb*, and turn the *Globe* through the *Meridian* till this *Rhumb* Cut the *Meridian* in the first *Latitude*, *viz.* in 10 degrees, and directly under 10 degrees upon the *Rhumb* I make a Prick, and also find 10 degrees 3 *Minutes* of the *Equator* at the *Meridian*, for the *Longitude* of the First Place. Then I turn the *Globe* again through the *Meridian*, till the same *Rhumb* Cut the *Meridian* in the Second *Latitude*, *viz.* in 30 degrees 40 Minutes, and directly under those 30 degrees 40 Minutes, in the same *Rhumb*, I make another Prick, which represents the Place I am Arrived to: I examine the *Longitude* of this Prick, as before, and find it 32 degrees 10 Minutes. Therefore I Subtract the First *Longitude*, *viz.* 10 degrees 3 Minutes, from the Second *Longitude*, *viz.* 32 degrees 10 Minutes, and there Remains 22 degrees 7 Minutes, for the difference of *Longitude*.

Then for Examining the *Distance*, I open my *Compasses* to 1 degree on the *Equinoctial*, and measure upon the *Rhumb* how oft that Distance is contained between the two Pricks, and find $29\frac{1}{4}$ that is 29 degrees 15 minutes, which multiplied by 20, gives 585 for the number of *Leagues* Sailed upon that *Rhumb*.

The Reason why I open the *Compasses* no wider than to 1 degr. is, because the *Rhumbs* being Circular or Crooked Lines, the distance on them may be measured more exactly, by often counting that 1 degr. in them, than if the *Compasses* had been opened to many degrees. Thus if the *Compasses* had been opened wide enough to reach between the two Pricks aforesaid, I should not have had above 583 *Leagues* for the distance between the two places: Neither is there indeed more *great Circle distance* between them; But I Sailed upon a *Rhumb*, that is, I follow'd

the *Course* of a Circular Winding Line, and so fetch a *Compass* about to come to these two Pricks; and therefore I have in truth Sailed 585 *Leagues*. For the segment of a *Rhumb* between two Places, is always greater than a straight Line drawn betwixt them; yea, sometimes by Half, or more, in Places near either *Pole*.

Note, If you be not very curious in opening your *Compasses* to this small distance, you may, in oft turning them about upon the *Rhumb*, commit error in your measuring: Therefore when you have taken the distance of one degree, try if you neither gain or lose any thing in measuring 10, or 20 degrees of the *Equinoctial* by them, for then your *Compasses* are opened to a width exact enough for your purpose.

## PROB. XII.

*The* Longitude *and* Latitude *of two* Places *given, to find* Course, *and* Great Circle *Distance between them.*

FInd on the *Globe* the *Longitudes* and *Latitudes* given, and make Pricks to either *Longitude* and *Latitude*: If any *Rhumb* pass from one Place to the Other, that is (without more ado) the *Rhumb* sought. But if no *Rhumb* pass through, take the *Rhumb* that runs most Parallel to the two Pricks: For that shall be the *Rhumb*, or the neareſt *Rhumb* that these two Pricks *Bear* on. An *Example* of this see in Prob. 34. of the last Book: And the *Great Circle Distance* between these two Pricks, you may find, as by Prob. 33. of the same Book.

## PROB. XIII.

*The* Latitude *you* departed *from, and the* Latitude *you are* arrived *to, and the number of* Leagues *you have* Sailed, *given, to find the* Rhumb *you have* Sailed *on, and Difference of* Longitude.

MAke a Prick on the *Globe* in the *Latitude* you *departed* from, then open your *Compasses* to the number of *Leagues* you have Sailed, by taking for every 20 *Leagues*, 1 degrees of the *Equator*, Half a degree for 10 *Leagues*, a Quarter

Quarter of a degree for 5 *Leagues*, and ſo proportionably for any other number of *Leagues*. Place one Foot of your *Compaſſes* in the Prick made for the *Latitude* you departed from, and extend the Other towards the *Latitude* you are arrived to, and deſcribe an occult Arch; Turn the *Globe* till this occult Arch come to the *Latitude* on the *Meridian*, and where the *Latitude* Cuts this occult Arch, make another Prick to repreſent the *Latitude* you are *arrived* to; ſo ſhall the *Rhumb*, paſſing through thoſe two Pricks (or that is moſt Parallel to thoſe two Pricks) be as in the laſt Prob. the *Courſe* or the *Rhumb* thoſe two Pricks *Bears* on.

The difference of *Longitude* you may find, as by Prob. 12.

## PROB. XIV.

*To find by the* Globe *the* Variation of the Needle; *commonly called the* Variation of the Compaſs.

OBſerve by a *Compaſs* whoſe Wyer is placed juſt under the *Flower-de-luce*, what Point of the *Compaſs* the *Sun* Riſes or Sets on, Morning, or Evening: Then examine by Prob. 16. of the Second Book, what degree of the *Horizon* the *Sun* Riſes or Sets on, by the *Globe* alſo; and if the Riſing or Setting be the ſame, both on the *Globe* and *Compaſs*, there is no *Variation* in your Place: But if there be difference between the Riſing or Setting by the *Compaſs* and the *Globe*, then is there *Variation* in your Place.

If the Point the Sun Riſes upon in the *Compaſs* be nearer the *North* Point, than the Point the *Sun* Riſes upon by the *Globe*, the *Variation* is Eaſtwards.

If the Point the *Sun* Sets upon in the *Compaſs* be nearer the North, than the Point it Sets upon by the *Globe*, the *Variation* is Weſtwards.

If the Point the *Sun* Sets upon in the *Compaſs* be further from the *North* Point, than the Point the *Sun* Sets upon by the *Globe*, the *Variation* is Eaſtwards.

If the Point the *Sun* Riſes upon in the *Compaſs* be further from the *North* Point, than the Point the *Sun* Riſes upon by the *Globe*, the *Variation* is Weſtwards. And ſo many degrees as there is between the Point of Riſing or Setting found by the *Compaſs*, and the Point of True Riſing or Setting found by the *Globe*, ſo many

many degrees in the *Variation* from the *North* towards the *East* or *West* Point.

### *Otherwise, when the* Sun *hath* Altitude.

Having the *Altitude* of the *Sun*; find by Prob. 22. of the Second Book, its *Azimuth*: Then examine by a *Compass* whether the true *Azimuth* found by the *Globe*, agree with the *Azimuth* found by a *Nautical Compass*: If they agree, there is no *variation*: But if the *Azimuth* of the *Compass* before Noon be nearer the *North*, than the true *Azimuth* found by the *Globe*, the *Variation* is Eastwards.

If the *Azimuth* by the *Compass* Afternoon be nearer the *North*, the *Variation* is Westwards.

If the *Azimuth* by the *Compass* Afternoon be further from the *North*, the *Variaton* is Eastwards.

If the *Azimuth* by the *Compass* before Noon be further from the *North*, the *Variation* is Westwards.

And this *Variation* shall be as aforesaid, so many degrees as there is between the *Azimuth*, Observed by the *Compass*, and the true *Azimuth*, Observed by the *Globe*.

## PROB. XV.

### *To Keep a* Journal *of the Ships* Way *by the* Globe.

BY some of these foregoing Problemes, you may Daily (when Observations can be made) find both the *Longitude* and *Latitude* on the *Globe*, of the Place you are Arrived to, and also the *Way* the Ship hath made, and make Pricks on the *Globe* in their proper Places for every days Voyage, so truly, and so naturally, that if you kept your reckoning aright, you may be sure you cannot miss any thing of the Truth it self, and that with less Trouble, and greater Advantage, than keeping a Book of every days Reckoning.

PROB.

## PROB. XVI.

### *To* Steer *in the* Night *by the Stars.*

REctifie the *Globe* and *Hour Index* as by Prob. 2. of the laſt Book, and turn about the *Globe* till the Index of the *Hour Circle* points to the Hour of the Day or Night; Then turn the *Globe* till the Difference of *Longitude* between the Place you depart from, and the place you Sail to, paſs through the *Meridian*; and if any *Star* in the *Latitude* of the Place you Sail to, Come to the *Meridian*, or near the *Meridian*, with the Degree of the Difference of *Longitude*, that *Star* is at that Time in or neer the *Zenith* of that Place you Sail to. And by finding the ſame *Star* in *Heaven*, as by Prob. 44. of the laſt Book, you may Direct your Ship towards that *Star*, and Sail as confidently (ſays Mr. *Blagrave*) as if *Mercury* were your Guide. But becauſe this *Star* Moves from the *Zenith* of this Place, you muſt often examine what *Star* is come to the *Zenith*, and ſo often Change the *Star* you *Steer* by, as the length of your Voyage may require.

## PROB. XVII.

### *How to* Platt *on the* Globe *New* Land, *never before Diſcovered.*

THeſe two following Problemes, are two Chapters of Mr. *Wright's*, delivered by him as follows.

It may ſometimes fall out in New Diſcoveries, or when your Ship, by means of a Tempeſt, is Driven out of her right *Courſe*, that you ſhall come to the ſight of ſome *Iſle*, *Shoal*, or *New Land*, whereof the *Mariner* is utterly ignorant: And to make ſome Relation of the ſame, or go unto it ſome other Time, If you deſire to Set it down on your *Globe* in the true Place, you may do it after this manner; So ſoon as you have Sight thereof, mark it well, Firſt with your *Compaſs*, Obſerving diligently upon which *Point* thereof it lieth. And Secondly, you muſt there take the Height of the *Sun*, or of the *Pole-ſtar*, as you were taught Prob. 13. of the Second Book, that you may know

in

in what Point your Ship is, and that Point you muſt call the *Firſt Point*; which being ſo done, your Ship may Sail on her *Courſe* all that Day, till the Day following, without loſing her Way: And the next Day mark the Land again, and ſee upon what *Point* it lieth; and then take your *height*, and with it *Caſt your Point of Traverſe* once again; and that you may call your *ſecond Point*. Then take a pair of *Compaſſes*, and placing one Foot upon the *firſt Point*, and the Other upon the *Rhumb* towards which the Land did *bear* when you *Caſt your firſt Point*; Set alſo one Foot of another pair of *Compaſſes*, in the *ſecond Point*, and the other Foot upon the *Rhumb* upon which the Land lay when you *Caſt your Second Point*, and theſe two *Compaſſes*, thus Opened, you muſt move by their *Rhumbs*, till thoſe two Feet of the *Compaſſes* do meet together, which were moved from the foreſaid *Two Points*: And where they do ſo meet together, there you may ſay is the Land which you Diſcovered; which Land you may Point out with the *In-lets*, and *Out-lets*, or *Capes*, and other *Signs*, which you ſaw thereupon. And by the Graduation you may ſee the *Latitude* thereof, that thereby you may find it, if at any time after you go to Seek for it.

## PROB. XVIII.

*Seeing two known* Points *or* Capes *of* Land, *as you Sail along, how to know the* diſtance *of your Ship from them.*

PItch one Foot of one pair of *Compaſſes* upon one of the two foreſaid *Capes*, and the other Foot upon the *Rhumb* which in the *Nautical Compaſs* points towards that *Cape*: And in like manner ſhall you do with another pair of *Compaſſes*, placing one Foot thereof upon the other known *Cape*, and the other Foot upon the *Rhumb* which ſtretched towards the ſaid Second *Cape*: And moving the two *Compaſſes* (ſo opened) by theſe two *Rhumbs* out from the Land, the very ſame Point where the two Feet which came from the two *Capes* do meet, you may affirm to be the very Point where your Ship is; And then meaſuring by the Degrees of the *Equinoctial*, you may ſee what Diſtance there is from the ſaid Point to either of the foreſaid *Capes*, or to any other Place, which you think good; for it is a very eaſie matter, if you know the Point where your Ship is.

PROB.

## PROB. XIX.

*Of* Tides, *and how by help of the* Globe, *you may in general Judge of them.*

DIvide the *Equinoctial* into 30 equal parts, as was directed in Prob. 54. of the laſt Book. Theſe 30 equal parts repreſent the 30 Days of the *Moons* Age.

Then on the *North* and *South* Points of the *Compaſs*, in the outmoſt Verge of the *Horizon*, write with red Ink 12. From the *North Eaſtwards*, *viz.* at the Point *North and by Eaſt*, write $11\frac{1}{4}$ At the next Point to the ſame way, *viz. North North Eaſt*, write $10\frac{1}{2}$ At the next, *viz. North and by North*, Write 9. And ſo forward to every Point of the *Compaſs*; rebating of the laſt Hour $\frac{3}{4}$ till you come to 12, in the *South*; where you muſt begin again to mark that Semi-Circle alſo in the ſame Order you did the laſt. In this Circle is then repreſented the *Points of the Compaſs* the *Sun* and *Moon* paſſeth by every Day; and the Figures annexed repreſent twice 12 Hours of Day and Night.

Having thus prepared your *Globe* and *Horizon*, you may, by having the *Moons* Age, and the *Point of the Compaſs* on which the *Moon* maketh *Full Sea* at any place given, find at what Hour of Day or Night it ſhall be *High Tide* in the ſame place. Thus,

It is a known Rule that a *North* and *South Moon* makes High Water at *Margarete*. Therefore Bring the firſt point of ♈ to the *North* or *South* Point in the *Horizon*, and Elevate the *North Pole* into the *Zenith*: Then Count in the *Equinoctial*, the Days of the *Moons* Age numbered in red figures, and the Hour and Minutes written in red figures, annexed to the Names of the Winds that ſtand againſt the *Moons* Age, ſhall be the Hour of High Tide on that Day or Night at *Margarete*.

*The End of the Third Book.*

# The Fourth BOOK.

Shewing the Practical Uſe of the

# GLOBES.

Applying them to the Solution of

## ASTROLOGICAL PROBLEMES.

## PRÆFACE.

THE Practice of Aſtrology is grounded upon a twofold Doctrine. The *firſt for Erecting a* Figure of Heaven, *Placing the Planets in it, Finding what Aſpects they Bear each other, and in what Place of* Heaven *they are conſtituted*, &c. *And this we call the* Aſtronomical *part of* Aſtrology.

*The Second is, How to Judge of the* Events of Things *by the* Figure Erected: *And this is indeed the only* Aſtrological *part.*

*The Firſt of theſe I ſhall briefly Handle; becauſe what therein is propoſed may be performed by the* Globe, *both with Speed, Eaſe, Delight and Demonſtration. The Second I ſhall not meddle with, but refer you to the whole Volumes already Written upon that Subject.*

PROB.

## PROB. I.

### *To* Erect a Figure *of the* 12 Houſes *of* Heaven.

BEfore you *Erect* a Figure of the 12 *Houſes* of *Heaven*, it will be requiſite you place the *Planets*, ☉ and ☾ according to their *Longitude* and *Latitude* upon the *Globe*, as was directed Prob. 55. of the Second Book: For then, as you Divide the *Houſes* of your *Figure* by the *Circle of Poſition*, you may, by inſpection, behold in what *Houſes* the Planets are Situated, and alſo ſee what Fixed *Stars* they are Applying to, or Separating from. But to the matter.

There is a diſagreement between the Ancient and Modern *Aſtrologers*, about *erecting* a *Figure* of *Heaven*. Mr. *Palmer* in his Book, *Spherical Problemes*, Chap. 48. mentions four ſeveral Ways, and the Authors that uſed them: Whereof one of them is called the *Rational Way* uſed by *Regiomontanus*; and now generally practiſed by all the *Aſtrologers* of this Age. This way the Face of *Heaven* is divided into Twelve parts, which are called the *Twelve Houſes of Heaven*, numbered from the *Aſcendent* or Angle at *Eaſt* downwards with 1, 2, 3, *&c.* As in the following Figure.

In a *Direct Sphere*, *viz.* under the *Equator*, theſe *Twelve Houſes* are twelve equal parts: But in an *Oblique Sphere* they are unequal parts, and that more or leſs according to the quantity of the *Spheres* Obliquity.

Theſe *Twelve Houſes*, are divided by 12 Semi-*Circles of Poſition*; which are Semi-Circles paſſing from the two interſections of the *Horizon* and *Meridian*, through any *Star*, Degree or Point in the *Heavens*.

Four of theſe *Houſes* are named *Cardinals*. The *Firſt* and moſt Eminent of theſe *Cardinals*, is the *Firſt Houſe*, or Angle of *Eaſt*, called the *Aſcendent*; where the Semi-Circle of *Poſition* is the ſame with the *Eaſtern* Semi-Circle of the *Horizon*. The *Second Cardinal*, is the *Tenth Houſe*, or the Angle of *South*, called *Medium Cœli*, or *Culmen Cœli*, where the Semi-Circle of *Poſition* is the ſame with the Semi-Circle of the *Meridian* above the *Horizon*. The *Third Cardinal* is the *Seventh Houſe*, or the Angle of *Weſt*, called the *Deſcendent*; where the Semi-Circle of *Poſition* is the ſame with the *Weſtern* Semi-Circle of the *Hori-*

*zon.* The *Fourth Cardinal* is the *Fourth Houſe*, or Angle of *North*, called *Imum Cœli*, where the Semi-*Circle of Poſition*, is the ſame with the Semi-Circle of the *Meridian* under the *Horizon*.

The Degrees and Minutes of the *Ecliptick* upon the *Cuſps* of theſe *Four Houſes* (that is, upon the beginning of theſe *Houſes*) are found all at once; only by bringing the Riſing Deg. of the *Ecliptick* to the *Horizon*: (for the *Horizon* repreſents the *Cuſp* of the *Aſcendent*) and then ſhall the *Meridian* Cut the Deg. of the *Ecliptick* on the *Cuſp* of the *Tenth Houſe*. The *Weſtern* Semi-circle of the *Horizon* ſhall cut the Deg. of the *Ecliptick* on the *Cuſp* of the *Seventh Houſe*: And the Semi-Circle of the *Meridian* under the *Horizon*, ſhall Cut the Degree of the *Ecliptick* on the *Cuſp* of the *Fourth Houſe*.

If you have the Day of the Month, you may, by Prob. 3. of the

the Second Book, find the *Suns* Place; and if you have the Hour of the Day, you may, by firſt Rectifying the *Globe*, as by Prob. 2. of the ſame Book, turn about the *Globe* till the *Index* of the *Hour-Circle* point to the ſame Hour in the *Hour-Circle*, and you will then at the *Eaſtern* Semi-Circle of the *Horizon*, have the Degree of the *Ecliptick* that is Riſing, and by Conſequence (as aforeſaid) all the *Cardinal Points* in their reſpective Places.

Now to find what Degree of the *Ecliptick* occupies the *Cuſps* of the other *Eight Houſes* of *Heaven*; Do thus, the *Globe* Rectified, as aforeſaid, Move the Semi-*Circle of Poſition* upwards, till 30 Degrees of the *Equator* ſhall be contained between it and the *Eaſtern* Semi-Circle of the *Horizon*; ſo ſhall the Semi-*Circle of Poſition* Cut in the *Ecliptick* the Degree and Minute of the *Ecliptick* on the *Cuſp* of the *Twelfth Houſe*; and its Oppoſite Degree and Minute in the *Ecliptick* ſhall be the *Cuſp* of the *Sixth Houſe*; for you muſt note, that if you have but the Deg. and Minute of the *Ecliptick* upon the *Cuſps* of Six of the *Houſes*, the Oppoſite Degrees and Minutes of the *Ecliptick* ſhall immediately poſſeſs the *Cuſp* of every Oppoſite *Houſe*.

Then move the *Circle of Poſition* over 30 Degrees more of the *Equinoctial*, ſo ſhall the Degree of the *Ecliptick*, Cut by the *Circle of Poſition*, be the Degree of the *Ecliptick* upon the *Cuſp* of the *Eleventh Houſe*; and its Oppoſite Degree in the *Ecliptick*, ſhall be upon the *Cuſp* of the *Fifth Houſe*. The Degree of the *Ecliptick* upon the *Cuſp* of the *Tenth* and *Fourth Houſes* was found as before. Then remove the *Circle of Poſition* to the *Weſtern* ſide of the *Meridian*, and let it fall towards the *Horizon*, till 30 Degrees of the *Equator* are contained between the *Meridian* and it, ſo ſhall the Deg. of the *Ecliptick*, Cut by the Semi-*Circle of Poſition*, be the Degree of the *Ecliptick* on the *Cuſp* of the *Ninth Houſe*; and the Oppoſite Degree of the *Ecliptick* ſhall be upon the *Cuſp* of the *Third Houſe*. Let the Semi-*Circle of Poſition* fall yet lower, till it paſs over 30 degrees more of the *Equator*, ſo ſhall the degree of the *Ecliptick*, Cut by the Semi-*Circle of Poſition*, be the degree of the *Ecliptick* on the *Cuſp* of the *Eighth Houſe*; and the Oppoſite degree of the *Ecliptick* ſhall be upon the *Cuſp* of the *Second Houſe*. The degrees of the *Ecliptick* on the *Cuſp* of the *Seventh Houſe*, and *Aſcendent*, were found as before.

*Example.*

*Example.*

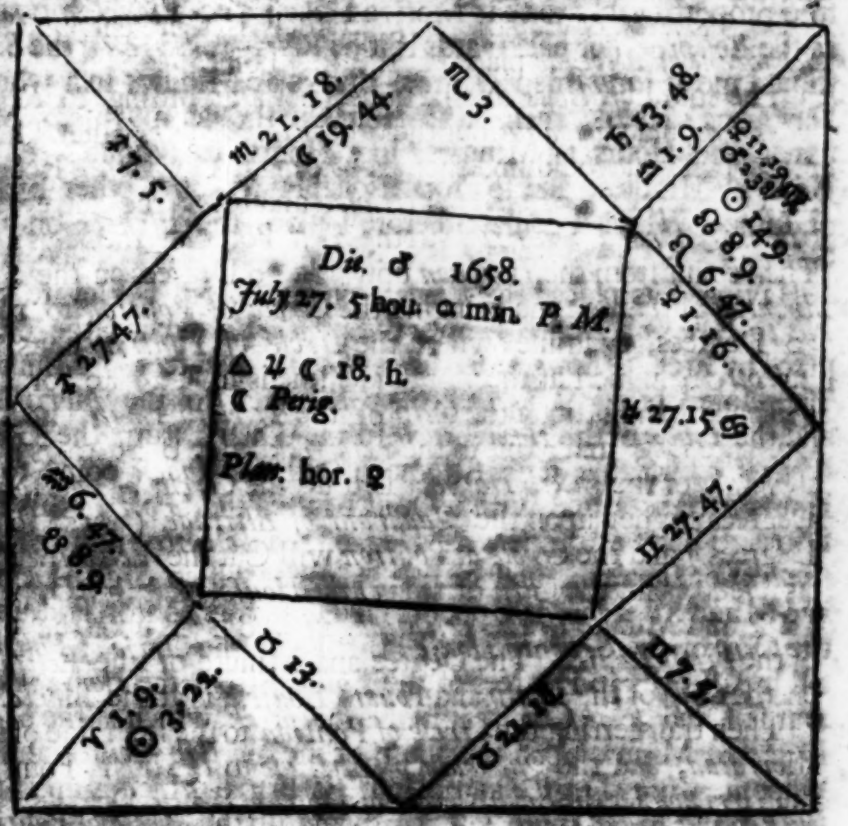
I would Erect a *Figure of Heaven* for *July* 27. 5 Hours, 0 Minutes Afternoon, 1658, in the *Latitude* of *London*, *viz.* 51½ Degrees, *North Latitude.*

I first place the *Planets*, ☌, and ☋ on the *Globe*, as by Prob. 55. of the second Book was directed: Yet not exactly as I find them in the *Ephemeris*, for that shews only their place in the *Ecliptick* at Noon: Therefore I consider how many Degrees or Minutes each *Planets* Motion is in a whole Day, or 24 Hours, by Subtracting the *Ecliptical* Degrees and Minutes of the *Planets* place that Day at Noon, from the *Ecliptical* Degrees and Minutes of the *Planets* place the next day at Noon: Or contrarily, if the *Planets* be *Retrograde*: For the Remains of those Degrees and Minutes is the Motion of the *Planet* that Day; Therefore proportionably to that Motion I place the *Planet* forward in the *Ecliptick*: (or backwards if it be *Retrograde*:) As if the *Sun* should move forwards 1 Degree, that is 60 Minutes in a whole Day, or 24 Hours, then in 12 Hours he should move 30 Minutes, in 6 Hours 15 Minutes, in 4 Hours 10 Minutes, in 1 Hour 2½ Minutes, and so Proportionably for any other Space of Time: Which I consider before I place the *Planets* on the *Globe.*

Having thus placed the *Planets* on the *Globe*, I Elevate the *North Pole* 51½ Degrees above the *Horizon*, and find the *Suns* place by Prob. 3. Book 2. to be in ☌ 14 Degrees 9 Minutes, Therefore I bring ☌ 14 Degrees 9 Minutes to the *Meridian*, and the *Index* of the *Hour-Circle* to 12. Then I turn the *Globe Westward*, because it is Afternoon, till the *Index* point to 5 Hours Afternoon, and with a Quill I fasten the *Globe* in this Position: Then I examine what Deg. of the *Ecliptick* is at the *Ascendent* or *Horizon*, and find ♐ 27 47 to which *Sign*, Degree and Minute ♊ 27 47 is Opposite; and therefore, as aforesaid, upon the *Cusp* of the *Seventh House*: Lifting up the *Circle of Position* till it pass over 30 Degrees of the *Equator* from the *Horizon* upwards, I find ♐ 75 Cut by it in the *Ecliptick*, which is the *Sign*, Deg. and Minute upon the Cusp of the *Twelfth House*, and its Opposite *Sign*, Degree and Minute is ♊ 7 5, which is upon the *Cusp* of the *Sixth House*: Then lifting up the *Circle of Position* again, till it pass over 30 Degrees more of the *Equinoctial*, I find

Cut

Cut by the *Circle of Position* ♏ 21 18 which is the *Sign*, Degree, and Minute upon the *Cusp* of the *Eleventh House*; and its Opposite *Sign*, Deg. and Minute is ♉ 21 18 which is upon the *Cusp* of the *Fifth House*. ♏ 3 20 is at the *Meridian*, which is the *Cusp* of the *Tenth House*, and the *Sign*, Deg. and Minute Opposite to it, is ♉ 3 20 which is on the *Cusp* of the *Fourth House*. Then taking the *Semi-Circle of Position* off its Poles, I place it in the *West* side the *Meridian*, and let it fall towards the *Horizon* till it pass over 30 degrees of the *Equator* from the *Meridian*, and find the *Circle of Position* cut the *Ecliptick* in ♎ 19 which is the *Sign*, Deg. and Minute on the *Cusp* of the *Ninth House*, Opposite to ♎ 19 is ♈, therefore ♈ 19 is upon the *Cusp* of the *Third House*: Letting the *Circle of Position* fall yet lower till it passes over 30 Degrees more of the *Equator*, I find it Cut the *Ecliptick* in ☊ 6 47 which is the *Sign*, Degree and Minute up-



on the *Cusp* of the *Eight House*; and its Oppofite *Sign*, Degree and Minute is ♒ 6,47. which is upon the *Cusp* of the *Second House*; So have you a *Figure* of the Face of Heaven; which if you have future uſe for, you may ſet down the ſeveral Characters in the proper places of a *Figure*, as they are on the other ſide the Leaf.

## PROB. II.

### *To Erect a* Figure *of* Heaven *according to* Campanus.

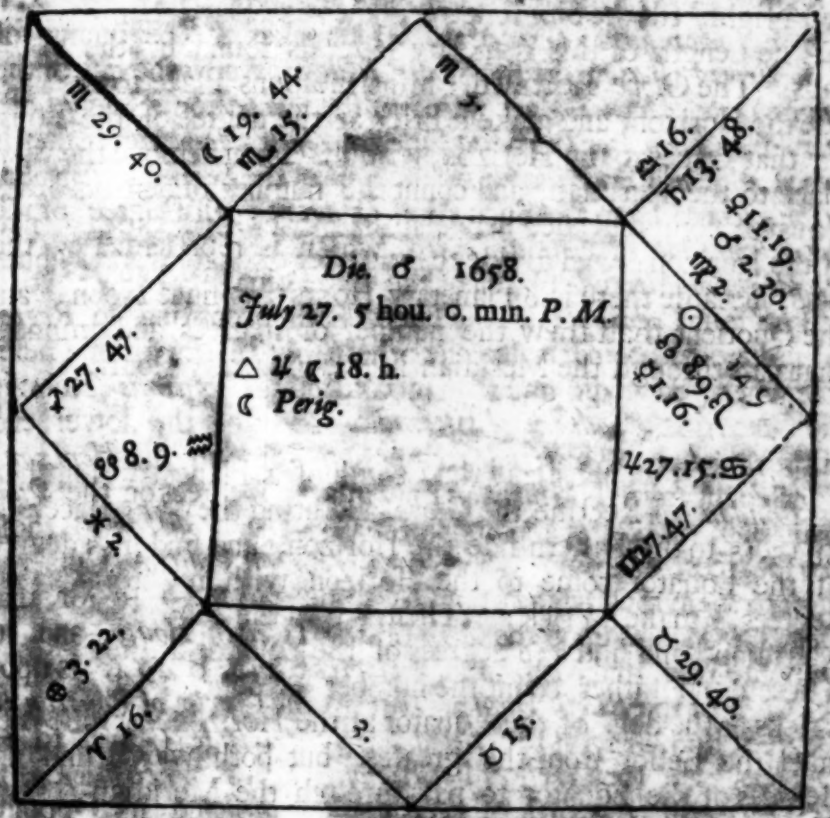
*Regiomontanus* (as aforeſaid) makes the beginning of every *Houſe* to be the *Semi-Circle* drawn by the ſide of the *Semi-Circle of Poſition*, according to the Succeſſion of every 30th Deg. of the *Equator* from the Horizon. But *Campanus* makes it to be the *Semi-Circle* drawn by the ſide of the *Semi-Circle of Poſition*, according to the Succeſſion of every 30th Degree of the *Prime Verticle*, or *Eaſt Azimuth*, which is repreſented by the *Quadrant of Altitude* placed at the *Eaſt* Point.

The four *Cardinals* are the ſame, both according to *Regiomontanus* and *Campanus*, but the other *Eight Houſes* differ. Therefore when you would find them according to *Campanus*; Rectifie the *Globe* and *Quadrant of Altitude*, and bring the lower end of the *Quadrant of Altitude* to the *Eaſt* Point in the *Horizon*: Then count from the *Horizon* upwards 30 Degrees on the *Quadrant of Altitude*, and bringing the *Circle of Poſition* to thoſe 30 Degrees, examine where the *Circle of Poſition* Cuts the *Ecliptick*; which at the aforeſaid Time is in ♏ 29 40 for that Deg. and Min. is upon the *Cuſp* of the *Twelfth Houſe*, and its Oppoſite Deg. and Min. in the *Ecliptick*, *viz.* ♉ 29 40 is upon the *Cuſp* of the *Sixth Houſe*: Lift up the *Circle of Poſition* 30 Degrees higher upon the *Quadrant of Altitude* (*viz.* to 60 Degrees) and the *Circle of Poſition* will Cut the *Ecliptick* in ♏ 15 Degrees for the *Cuſp* of *Eleventh Houſe*, and its Oppoſite Deg. and Minute in the *Ecliptick*, *viz.* ♉ 15 is upon the *Cuſp* of the *Fifth Houſe*. The Degree and Minute of the *Ecliptick* on the *Cuſp* of the *Tenth* and *Fourth Houſes*, is at the *Meridian*.

Then transferring the *Circle of Poſition* to the *Weſt* ſide of the *Meridian*, and the *Quadrant of Altitude* to the *Weſt* Point in the *Horizon*, let the *Semi-Circle of Poſition* fall 30 Degrees from the *Meridian* of the *Quadrant of Altitude*, and it will Cut in the

*Ecliptick*

*cliptick* ♎ 16 degrees, for the *Cuſp* of the Ninth Houſe, and its oppoſite degree and minute in the Ecliptick, *viz.* ♈ 16. is upon on the *Cuſp* of the Third Houſe: Let fall the *Circle of Poſition* 30 degrees lower on the *Quadrant of Altitude*, and it will Cut the Ecliptick in ♍ degrees for the *Cuſp* of the Eighth Houſe, and its oppoſite degree, *viz.* ♓ 2 degrees, is on the *Cuſp* of the Second Houſe: The *Cuſps* of the Seventh and Aſcendant, is the ſame with *Regiomontanus*, *viz.* 27, 47, and ♐ 27, 47. The Figure follows.




## PROB. III.

### *To find the Length of a* Planetary Hour.

*Aſtrologers* divide the Artificial Day (be it long or ſhort) into 12 Equal Parts, and the Night into 12 Equal Parts: Theſe Parts they call Planetary Hours. The

First of these Planetary Hours, takes its denomination from the Planetary Day; and the rest are named orderly from that Planet, according to the Succession of the Planetary Orbs. As if it be *Monday*, that is the *Moon's* Day, (as by Prob. 42. of the Second Book,) the Planet Reigning the First Hour shall be ☽, the Planet Ruling the Second Hour shall be ♄, the Third Planetary Hour shall be ♃, the Fourth ♂, the Fifth ☉, the Sixth ♀, the Seventh ☿: Then begin again with ☽ for the Eighth Planetary Hour, ♄ for the Ninth, and so through the whole Day and Night, till the *Sun* Rise again the next Day.

The Length of this Planetary Hour is found by the *Globe* thus, The *Globe* Rectified, bring the Suns Place to the East-side the Horizon, and make a Prick at the degree of the Equator that comes to the Horizon, with it. Then remove the *Suns* place to the Meridian, and count the number of degrees of the Equator, comprehended between that Prick and the deg. now at the Horizon; and divide that number of degrees and minutes by 6, because there is 6 Planetary Hours past since Noon; and the Quotient shall shew the number of degrees and minutes, that pass through the Meridian in one Planetary Hour.

*Example.*

*July* 27. I would know the Length of a Planetary Hour here at *London*: I Rectifie the *Globe*, and bring the *Suns* place, *viz.* ♌ 13. 15 to the Eastern-side the Horizon, and find 115 degrees of the Equator come to the Horizon with it, to this 115 degrees, I make a Prick: Then I turn the *Suns* place to the Meridian, and find 226 degrees of the Equator at the Horizon. Therefore I either count the number of degrees between the Pricks at the deg. of the Equator at the Horizon, or else subtract the Lessor from the greater, but both ways I find 111 degrees of the Equator to pass through the Meridian (or the Horizon,) in six Planetary Hours: Therefore dividing 111 by 6, I find 18 deg. 30. min. of the Equator, to pass through the Meridian in one Planetary Hour; which 18 degrees 30 minutes reduced into Time, yields 74 Minutes, by accounting for every 15 degrees one hour, for 1 deg. 4 minutes, and for half a deg. 2 minutes of Time, and so proportionably; so that the Length of a Planetary Hour, *July* 27, is 1 common Hour and 14 Minutes here at *London*.

PROB.

## PROB. IV.

*The Length of a* Planetary Hour *known, to find what* Planet Reigneth, *any given* Hour *of the Day or Night.*

THE *Globe* Rectified, as in the last Probleme; Turn about the *Globe* till the *Index* of the Hour-Circle points to the Hour of the Day in the Hour-Circle. Then count the number of degrees comprehended between the deg. of the Equator at the Horizon, and the Prick in the Equator, made as in the last Probleme, and reduce that number of degrees into Minutes of Time, by reckoning 4 Minutes of Time for every deg. of the Equator. Reduce also the number of degrees and Minutes that pass through the Meridian in one Planetary-Hour into Minutes, by allowing (as aforesaid,) 4 Minutes for every deg. and then divide the First number by the Second, and the Quotient shall be the number of Planetary Hours since Sun-Rising. Having the number of Planetary Hours since Sun-Rising; reckon the First Planetary Hour, by the name of that Planet that bears the denomination of the Day, the Second Planetary Hour by the Planet succeeding that in order, the Third by the next in order, and so for all the rest, till you come to the last Planet, *viz.* ☾; and then begin again with ♄, and so to ♃, *&c.* till you have reckoned so many Planets as there are Planetary Hours since Morning; and that Planet the number ends on, shall be the Planet Reigning that Planetary Hour.

*Example.*

*July* 27. as aforesaid, I would know what Planet Rules at 5 a Clock past Noon: The Length of the Planetary Hour this Day (found by the last Probleme,) is 1 Hour 14 Minutes: Therefore the *Globe* Rectified, I bring the *Index* of the Hour-Circle, to the Hour of the Day, *viz.* 5 a Clock in the Hour-Circle, and then count the number of degrees between the Prick made, as by the last Probleme, and the deg. of the Equator at the Horizon; and find them 187, which I reduce into Minutes, by allowing for every deg. 4 minutes, and that gives 748 Minutes. This 748 Minutes, I divide by the Minutes contained in one Plane-

tary Hour this Day, *viz.* by 72, and find 10 Hours 8 Minutes; which ſhews, there are 10 *Planetary Hours* and 8 Minutes paſt and gone ſince *Sun* Riſing. Therefore ♂ being the *Planet*, after whoſe Name the Day is called, *viz. Dies Partis*, ♂ is, as aforeſaid, the Ruler of the Firſt *Planetary Hour*: From him I count the *Planet* ſucceeding, which is ☉ for the *Second hour*; from ☉ I count the Planet ſucceeding, which is ♀ for the *Third hour*, and ſo on to ☿ and ☽; and then I begin the Round again with ♄, ♃, ♂, and ☉, till I come again to ♀, which is the *Tenth Planetary Hour* ſince *Sun* Riſing; and the Minutes remaining being 8, ſhews, that there is 8 Minutes paſt ſince ſhe began to *Reign*.

## PROB. V.

### *To find* Part of Fortune *by the* Globe.

COunt the number of Degrees and Minutes contained between the *Suns* place and the *Moons* place, beginning at the *Suns* place, and counting according to the ſucceſſion of *Signs*, till you come to the *Moons* place; and having found that number of degrees and minutes, add them to the number of degrees and minutes *Aſcending*, reckoned from the firſt point of ♈. If the Sum exceed 360, caſt away 360, and the Remainder ſhall be the number of degrees and minutes from the firſt point in ♈, in which *Part of Fortune* falls. But if it do not exceed 360, you have already the number of degrees and minutes from the firſt point of ♈, in which you muſt place *Part of Fortune*.

### *Example.*

I would find the place of *Part of Fortune*, for the Time of our *Figure*; I ſeek the two Pricks repreſenting ☉ and ☽, and find ☉ in ♌ 14 9 and in ♏ 19 44: Therefore, counting from the *Suns* place to the *Moons* place, according to the ſucceſſion of *Signs*, I find 95 degrees 35 minutes contained between them: This 95 degrees 35 minutes, I add to 267 degrees 47 minutes, the degree and minute contained between the firſt point of ♈, and the *Aſcendent*, and they make together 363 degrees 22 minutes. This exceeds 360, therefore I caſt away 360, and the Remains are 3 degrees 22 minutes, for the place in the *Ecliptick* of *Part of Fortune*, reckoned from the firſt point of ♈.

Therefore

Therefore, this Character ☌, which represents *Part of Fortune*, I set in its proper place of the *Figure*, as I did the *Planets*.

## PROB. VI.

### *To find in what* Circle *of* Position *any* Star, *or any Degree of the* Ecliptick *is.*

CIrcles of *Position*, are numbered from the Horizon upward, upon the *Quadrant of Altitude*, placed at the *East* or *West* point of the Horizon. Therefore, when you would find what *Circle of Position* any *Star*, or Degree of the *Ecliptick* is in, Rectifie the *Globe* and *Quadrant of Altitude*, and bring the lower end of the *Quadrant of Altitude* to the *East* or *West* point of the Horizon, and lift up the *Circle of Position*, till it come to the *Star*, or Degree of the *Ecliptick* proposed, and the number of Degrees the *Circle of Position* then cuts in the *Quadrant of Altitude*, is the number of the Circle of Position, that the *Star*, or Degree of the *Ecliptick* is in. If the *Star* or deg. of the *Ecliptick* be under the Horizon, turn the *Globe* about till 108 degrees of the *Equator* pass through the *Meridian*, then will the *Star* or deg. of the *Ecliptick* be above the Horizon: Lift up then the Circle of Position (as before,) to the *Star* or deg. of the Ecliptick, and the number of degrees of the Quadrant of Altitude, the Circle of Position cuts on the *East* side, is the number of Circles of Position the *Star* was under the Horizon on the *West* side; or so many degrees as the Circle of Position cuts on the Quadrant of Altitude in the West-side the Horizon, is the number of the Circles of Position the *Star*, or degree of the Ecliptick, was under the Horizon on the East-side.

## PROB. VII.

### *To find the* Right Ascensions, *the* Oblique Ascensions, *and the* Declinations *of the* Planets.

EXamine the Right Ascensions and Declinations of those Pricks, made to represent each Planet, in Prob. 1. of this Book; and work by them as you were directed to work by the *Sun*, in Prob. 26, 27, 28. of the Second Book.

PROB.

## PROB. VIII.

### *How to* Direct *a* Figure *by the* Globe.

TO direct a Figure, is to Examine how many degrees of the Equinoctial are moved Eastwards or Westwards, while any Planet or Star in one House comes to the Cusp, or any other Point of any other *House*.

When you would direct any *Promittor* to any *Hylegiacal* Point, examine the degree of the Equator at the Meridian; then turn about the Globe till the *Promittor* come to the *Hylegiacal* Point, and examine again the Degree of the Equator at the Meridian; and by subtracting the Lesser from the Greater, you will have the number of degrees that passed through the Meridian, while the place of the *Promittor* was brought to the *Hylegiacal* Point; and that number of degrees shall be the Arch of Direction.

### *Example.*

I would *direct* the Body of the *Moon* in our Figure aforesaid, to *Medium Cœli*, or the Tenth House: I find by the *Globe* 203 degrees 30 minutes of the Equator at the Meridian with the Tenth House, and turning the *Globe* till the Prick made to represent the *Moon*, come to the Meridian, I find 227 degrees 20 minutes of the Equator come to the Meridian with it; therefore I subtract the Lesser from the Greater, *viz.* 203 degrees 30 minutes, from 227 degrees 20 minutes, and have remaining 23 degrees 50 minutes.

This 23 degrees 50 minutes, shews that 23 Years 10 Months must expire, e'er the Effects promised by the Moons present Positions, shall operate upon the Signification of the Tenth House.

If the Body of the *Moon* had been *directed* to any other Point than the Meridian or Horizon; you must have Elevated the Circle of Position to the Point proposed; and have underproped it to that Elevation, and then have turned about the *Globe* till the Prick representing the *Moon*, had come to the Circle of Position; and then the degrees of the Equator that should have passed

paſſed through the Meridian whiles this Motion was making, ſhould be the number of degrees of Direction; and ſignifie in Time as aforeſaid.

## PROB. IX.

### Of Revolutions; *and how they are found by the* Globe.

BY a Revolution, is meant the Annual Converſion of the *Sun* to the ſame Place he was in at the Radix of any Buſineſs. When you would find a Revolution by the Globe, firſt find the Right Aſcenſion of Mid-Heaven at the Radix of the Buſineſs, as by Prob. 26. of the Second Book, you were directed to find the Right Aſcenſion of the *Sun*; and to it, add 87 degrees for every Year ſince the Radix: Then Subtract 360 ſo oft as you can from the Whole, and the Remains ſhall be the Right Aſcenſion of Mid-Heaven for the Annual Revolution.

If you count the number of degrees of the Equator, contained between the Right Aſcenſion of the Mid-Heaven, and the Right Aſcenſion of the Sun, and convert that number of degrees into Time, by allowing for every 15 degrees 1 Hour of Time, it will ſhew, if the *Suns* Place be on the Weſtern-ſide of the Meridian, the number of Hours and Minutes Afternoon the Revolution ſhall happen on; but, if on the Eaſt-ſide the Meridian, the number of Hours and Minutes Beforenoon the Revolution ſhall happen on.

## PROB. X.

### *How a* Figure *of* Heaven *may be Erected by the* Revolution *thus found.*

SEEK the degree of Right Aſcenſion of Mid-Heaven, and bring it to the Meridian, ſo ſhall the Four Cardinal Points of the Globe, be the ſame with the Four Cardinal Points in Heaven, at the Time of the Revolution. The other Houſes are found by the Circle of Poſition; as in the firſt Probleme of this Book.

*The End of the Fourth Book.* The

# The Fifth BOOK.

## Shewing the Practical Uſe of the

# GLOBES.

## Applying them to the Solution of

## GNOMONICAL PROBLEMES.

## PRÆFACE.

DIALS *are of two Sorts*, Pendent, *and* Fixed, Pendent *are ſuch as are Hung by the Hand, and Turned towards the* Sun; *that by its Beams darting through ſmall Pin-holes made for that purpoſe, the Hour of the Day may be found. Theſe are of two Sorts*, Univerſal, *and* Particular.

Univerſal Dials, *are thoſe, commonly called* Equinoctial *or* Ring-Dials: *They are Uſed by Sea-men and Travellers, that often ſhift* Latitudes.

Particular, *are ſuch as are made, and only ſerve for Particular* Latitudes. *Of theſe Sorts are the ſeveral* Dials *deſcribed on* Quadrants, Cilinders, *&c.*

Fixed Dials *ſhall be the Matter of this Diſcourſe; and they are ſuch as are made upon Fixed Plains, and ſhew the Hour of the Day by a* Stile, *or* Gnomon, *made* Parallel *to the* Axis *of the* World.

Of

## *Of the ſeveral* Kinds *of* Dyal Plains: *And how you may know them.*

A *Plain* in *Dyaling* is that Flat whereon a *Dyal* is Deſcribed.

There is ſome diſagreement among Old and Later Authors in the Naming of *Plains*: For ſome Name them according to the *Great Circle* in *Heaven* they *Lye* in, and others according to the *Situation* of the *Poles* of the *Plains*. Thus they which Name them according to the *Great Circle* in *Heaven* their *Plains* Lye in, Call that an *Horizontal Plain*, which others call a *Vertical Plain*, thoſe *Vertical Plains*, which others will Call *Horizontal*; and thoſe *Polar*, which others Call *Equinoctial*.

However they be Called it matters not, ſo you can but diſtinguiſh their Kinds, which with a little Conſideration you may eaſily learn to do: For remembering but upon what Grounds either the Older or Later Authors gave their *Plains* their Names, upon the ſame Grounds you may alſo learn to know them. I confeſs both ways admit of ſome juſt Exception againſt, for in the Older Rule, a *Plain* about the *Pole*, is called an *Equinoctial Plain*; when as to a ſudden apprehenſion it will Sound more Significant to Call it a *Polar Plain*, as Later Authors do: Again, Later Authors Call an *Horizontal Plain* a *Vertical Plain*; when as it Sounds more Significant to Call it an *Horizontal Plain*, as Older Authors do: Becauſe it lies Flat upon the *Horizon*: But I ſhall give you the Names according to both Rules, and leave you to your liberty to accept of which you pleaſe.

Firſt therefore, you have an *Equinoctial Plain*, or otherwiſe called a *Polar Plain*. This *Plain* hath two *Faces*, Upper and Under: Theſe two *Faces* lye in the *Plain* of the *Equinoctial*, the Upper *Face* beholding the Elevated *Pole*, the Under *Face* the Depreſſed *Pole*.

2. An *Horizontal Plain*, otherwiſe called a *Vertical Plain*; it lies in the *Plain* of the *Horizon*, directly beholding the *Zenith*.

*Erect Plains*, otherwiſe called *Horizontal Plains*, are the Sides of Walls, and theſe are of ſeven Sorts, *viz.* 1. *Erect Direct Vertical*, *North* or *South*. 2. *Erect Direct*, *Eaſt* or *Weſt*. 3. *Erect Vertical Declining*. 4. *Erect Inclining Direct*. 5. *Erect Inclining Declining*. 6. *Erecting Reclining Direct*. 7. *Erect Reclining Declining*.

3. *Erect Vertical*, *North* or *South Direct*, otherwiſe Called

*Direct North*, or *South Horizontals*, behold the North or South *Directly*, and lye in the East or West *Azimuth*.

4. Erect Direct East or West, otherwise called Direct East or West Equinoctials, behold the East or West Directly, and lyes in the Plain of the Meridian, having its Poles in the Equinoctial.

5. Erect Vertical Declining Plains, otherwise called Declining Horizontals, do not behold the North or South Directly, but swerves from them so much as the Azimuth Parallel to their Plains, swerves or declines from them.

6. Erect Inclining Direct Plains, have the Upper-side of their Plains Inclining, or coming towards you, and their Plains do exactly behold either the East, West, North, or South.

7. Erect Reclining Direct Plains, have the Upper-side of their Plains Reclining or falling from you, and their Plains exactly beholding either the East, West, North, or South.

8. Erect Reclining Declining, or Erect Inclining Declining Plains, are those Plains which are either Inclining or Reclining, but do not behold the East, West, North, or South Directly, but swerve or decline more or less from them.

9. Polar Plains are Parallel to the *Axis* of the World, and to the *Meridians* that cuts the East and West, or North and South Points of the Horizon.

All these Kinds of Plains have two Faces; the one beholding the North Pole with the same respect that the other beholds the South Pole; except the Equinoctial Plain, which because neither Pole is Elevated, hath but one Face; yet that one contains as many Hour Lines as two other Faces.

These two Faces, or Plains, will receive just 24 Hour-Lines, for the 24 Hour-Lines of Day and Night; for so much as the one Side or Face wanteth or exceedeth 12, the other Side shall either exceed or want of 12.

Every Dial Plain is Parallel to the Horizon of some Country or other, of the Earth: Therefore a Dial made for any Horizon of the Earth, may be Set to such a Position, that it will shew you the Hour of the Day in your own Habitation; at least for so long as the *Sun* continues upon that Plain.

All Plains may be aptly demonstrated by the Globe, by setting it correspondent to all the Circles in Heaven, as by Prob. 2. of the Second Book; for if you imagine the Globe in that Position were prest flat into the Plain of any Circle, that Flat shall repre-

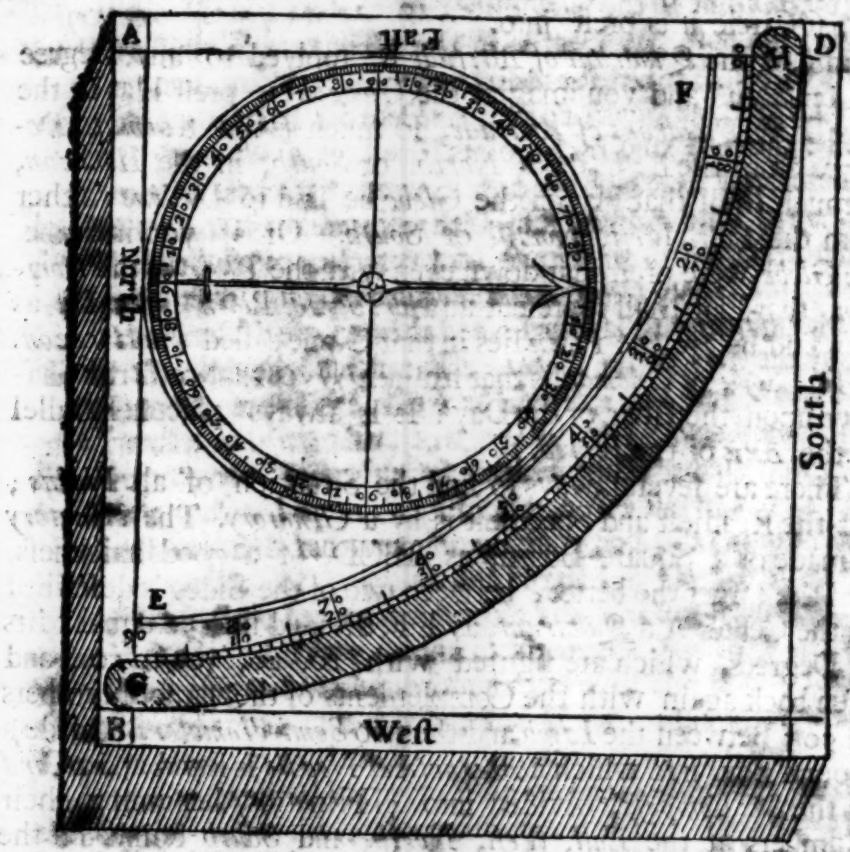
repreſent a *Dyal plain*, which ſhall be Called after the Name of that Circle it is preſt into.

Thus if the *Quadrant of Altitude* be applyed to any Degree of *Azimuth*. and you imagine the *Globe* were preſt Flat to the edge of the *Quadrant of Altitude*, ſo much as that *Azimuth Declines* from the *Eaſt*, *Weſt*, *North*, or *South*, in the *Horizon*, ſo much ſhall that Flat on the *Globe* be ſaid to *Decline* either from the *Eaſt*, *Weſt*, *North*, or *South*. Or if you imagine, the *Globe* were preſt Flat down even with the *Plain* of the *Horizon*, that Flat ſhall repreſent an *Horizontal Plain*; becauſe as was ſaid before, the *Plain* lies in that Circle called the *Horizon*.

The *Style* or *Gnomon*, is that ſtraight Wyer that caſts the Shadow upon the Hour of the Day: It is always placed Parallel to the *Axis* of the *World*.

There are ſeveral ways to find the Situation of all *Plains*; but the Readieſt and Speedieſt is by a *Clinatory*. The *Clinatory* is made of a Square Board, as ABCD, of a good thickneſs, and the larger the better; between two of the Sides is deſcribed on the Center A a *Quadrant*, as E F, divided into 90 equal parts or Degrees, which are figured with 10, 20, 30, to 90; and then back again with the Complements of the ſame Numbers to 90: Between the *Limb* and the two *Semi-diameters* is made a Round Box, into which a *Magnetical Needle* is fitted, and a *Card* of the *Sea Compaſs*, divided into 4 Nineties, beginning their Numbers at the *Eaſt*, *Weſt*, *North*, and *South* Points of the *Compaſs*, from which Points the oppoſite Sides of the *Clinatory* receive their Names of *Eaſt*, *Weſt*, *North*, and *South*. Upon the *Center* A, whereon the *Quadrant* was deſcribed, is faſtened a *Plumb-line*, having a Plumbet of *Lead* or *Braſs* faſtened to the end of it, which *Plumb-line* is of ſuch Length, that the *Plumet* may fall juſt into the *Grove* G H below the *Quadrant*, which is for that purpoſe made of ſuch a Depth, that the *Plumet* may ride freely within it, without ſtopping at the Sides of it. See the *Figure* annexed.

With this *Clinatory* you may Examine the Situation of *Plains*: As if your *Plain* be *Horizontal*; it is *Direct*: And then for the true Situating your *Dyal*, you have only the true *North* and *South* Line to find: Which is done only by ſetting the *Clinatory* flat down upon the *Plain*, and turning it towards the Right or Left Hand, till you can bring the *North* Point of the *Needle* to Hang




just over the *Flower-de-luce*, for then if you draw a Line by either of the Sides Parallel to the *Needle*, that Line shall be a *North* and *South* Line. But herein respect must be had to the *Variation* of the *Compass* in the Place you make your *Dyal*: For if the *North* Point of the *Needle* swerves from the *North* Point of the *World*, then have you not a true *North* and *South* Line. But if in your Place there be no *Variation* of the *North* Point of the *Needle* from the *North* Point of the *World*, (as now it happens here at *London*) then the Line drawn by the Side of the *Clinatory* (as aforesaid) shall be a true *North* and *South* Line.

But admit there be *Variation*, Having by Prob. 19. of the Third Book found the number of Degrees of this *Variation* towards the *East* or *West*, Count the same number of Degrees from the

the *North* Point in the *Card* either to the *Eaſtwards* or *Weſtwards*; and note the Degree in the *Card* terminating at that Number, for that Degree ſhall be the *North* Point, and its Oppoſite Degree the *South* Point: 90 Degrees from it either way ſhall be the *Eaſt* and *Weſt* Points.

Therefore whereas before you were directed to turn the *Clinatory*, till the *North* Point of the *Needle* point to the *Flower-de-luce* on the *Card*, you muſt now turn (or move) the *Clinatory*, till the *North* Point of the *Needle* Hang juſt over the Degree of *Variation* thus found; and then a Line drawn, as aforeſaid, by the Side of the *Clinatory* Parallel to the *Needle*, ſhall be a *North* and *South* Line, or (to ſpeak more properly) a *Meridional* Line.

You may find a *Merdian* Line ſeveral other ways, as, *Firſt*, If the *Sun Shine* juſt at Noon, hold up a *Plumb-line* ſo as the Shadow of it may fall upon your *Plain*; and that Shadow ſhall be a *Meridian* Line.

*Secondly*, on the Back-ſide the *Clinatory* deſcribe a Circle, and draw a Line through the *Center* to both ſides the Circumference; Croſs this Line with another Line at Right Angles in the Center, ſo ſhall the Circle be divided into four equal parts. Theſe four parts you muſt mark with *Eaſt*, *Weſt*, *North*, *South*, and divide each of them into 90 Degrees. In the Center of this *Plain* erect a ſtraight Wyer perpendicularly: When you would find a *Meridian* Line, examine by the 10 Prob. of the 2d Book, the *Amplitude* of the *Suns* Riſing or Setting from the *Eaſt* or *Weſt* Points, and waiting the juſt Riſing or Setting that Day, turn the Inſtrument about till the Shadow of the Wyer falls upon the ſame Degree from the *Eaſt* or *Weſt* the *Amplitude* is of, for then the *North* and *South* Line in the *Inſtrument*, will be the ſame with the *North* and *South* Line in *Heaven*.

*Thirdly*, by the *Suns Azimuth*: Find the *Azimuth* of the *Sun* by Prob. 22. of the Second Book: And at the ſame inſtant, turn the Inſtrument till the Shadow of the Wyer fall upon the Degree on the Inſtrument, oppoſite to the Degree of the *Suns Azimuth*, ſo ſhall the *Meridional* Line of the Inſtrument agree with the *Meridional* Line in *Heaven*.

You may the ſame way work by the *Azimuth* of any *Star*: Only, whereas the Shadow of the Wyer ſhould fall upon the oppoſite Degree aforeſaid, now you muſt place a *Sight* or Perpendicular upon that oppoſite Degree, and turn the Inſtrument about

bout till the Wyer at the *Center*, the *Sight* in the oppoſite Degree of the *Stars Azimuth*, and the *Star* in *Heaven*, come into one ſtraight Line, ſo ſhall the *Meridian* Line of the Inſtrument, agree with the Meridional Line in Heaven.

Fourthly, It may be found by any *Star* Obſerved in the Meridian, if two Perpendiculars be erected in the Meridian Line of your Inſtrument, for then by turning the Inſtrument till the two Perpendiculars and the *Star* come into a ſtraight Line, the Meridian Line of your Inſtrument will be the ſame with the Meridian Line in *Heaven*. See more Ways in Mr. *Palmer* on the Planiſphere, Book 4. Chap. 7.

If your Plain either Recline or Incline, apply one of the Sides of your Clinatory Parallel, to one of the Semi-diameters of the *Quadrant* to the Plain, in ſuch ſort that the Plumb-line Hanging at liberty, may fall upon the Circumference of the *Quadrant*, for then the number of Degrees of the *Quadrant* comprehended between the Side of the *Quadrant* Parallel to the Plain and the Plumb-line, ſhall be the number of Degrees of Reclination, if the Center of the *Quadrant* points Upwards; or Inclination, if the Center points Downwards.

If your Reclining or Inclining Plain Decline, Draw upon it a Line Parallel to the Horizon, which you may do by applying the back ſide of the Clinatory, and Raiſing or Depreſſing the Center of the *Quadrant*, till the Plumb-line Hang juſt upon one of the Semi-diameters, for then you may by the Upper ſide of the Clinatory, draw an Horizontal Line, if the Plain Incline, or by the Under ſide, if it Recline. If it neither Incline nor Recline, you may draw an Horizontal Line both by the Upper and Under Sides of the Clinatory. Having drawn the Horizontal Line, apply the North ſide of the Clinatory to it, and if the North end of the Needle points directly towards the Plain, it is then a South Plain. If the North point of the Needle points directly from the Plain, it is a *North* Plain: But if it points towards the *Eaſt*, it is an *Eaſt*-Plain: If towards the *Weſt*, a *Weſt* Plain: If it do not point directly either *Eaſt*, *Weſt*, *North* or *South*, then ſo many degrees as the Needle declines from any of thoſe four Points, to any of the other of theſe four Points, ſo many degrees is the declination of the Plain, with reſpect (as aforeſaid) had to the Variation of the Compaſs.

Or if you find the Azimuth of the *Sun*, by its Altitude Obſerved

ſerved juſt when its Beams are coming on or going off your Plain, that Azimuth ſhall be the Azimuth of your Plain.

Or you may erect a Wyer Perpendicularly on your Plain, and wait till the Shadow of that Wyer comes to the Perpendicular with the Horizon, which you may examine by applying a Plumb line to it, for then the Shadow of the Plumb-line and the Shadow of the Perpendicular will be in one: Then taking the Altitude of the *Sun*, you may, by Prob. 22. of the Second Book, find its Azimuth, and thereby know in what Azimuth the Plain of your Dyal lies: For the Azimuth your Plain lies in, is diſtant from the Azimuth of the *Sun* juſt 90 degrees.

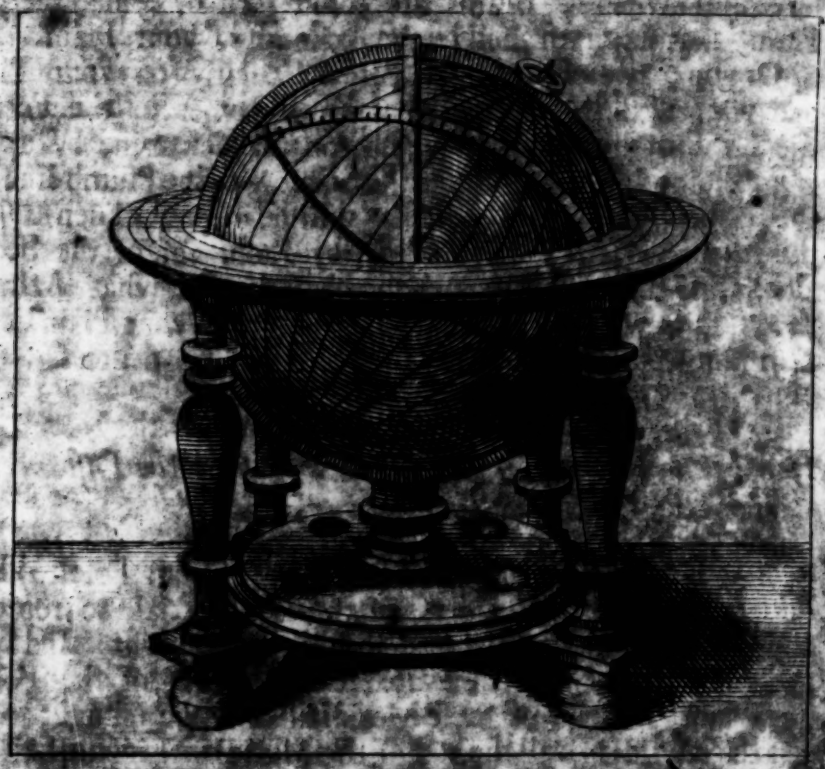
## PROB. I.

*How by one Poſition of the* Globe, *to find the Diſtances of the* Hour-lines *in all manner of* Plains.

YOU may have Meridian Lines drawn from Pole to Pole, through every 15 deg. of the Equinoctial, to repreſent the Horary Motion of the *Sun* both day and night: And when the Pole of the *Globe* is Elevated to the Height of the Pole in any Place, and one of theſe Meridian Lines be brought to the Brazen Meridian, all the reſt of the Meridian Lines, ſhall Cut any Circle which you intend ſhall repreſent the Plain of a *Dyal*, in the number of degrees on the ſame Circle, that each reſpective Hour-line is diſtant from the Noon-line Point in the ſame Circle.

Thus if you ſhould enquire the diſtance of the Hour-lines upon an Horizontal Plain in *London*'s Latitude; The Pole of the *Globe* (as aforeſaid) muſt be Elevated 51½ degrees, and one of the Meridian Lines (you may chuſe the Vernal Colure) be brought to the Brazen Meridian, which being done, you are only to examine in the Horizon (becauſe it is an Horizontal Plain) at what diſtance from the Meridian (which in Horizontals is the Noon-line) the ſeveral Meridians drawn on the *Globe* interſect the Horizon, for that diſtance in Degrees, ſhall be the diſtance on a Circle divided into 360 degrees, that each reſpective Hour-line muſt have from the Meridian, or a Noon-line choſen in the ſame Circle: And Lines drawn from the Center of that Circle through thoſe degrees, ſhall be the Hour-lines of an Horizontal Plain.

If it be an Erect Direct *South* Dyal you enquire after; Keeping



ing the *Globe* in its former Poſition, apply the *Quadrant of Altitude* to the *Zenith*, and its lower end to the *Eaſt* Point of the *Horizon*, for then (as was ſhewed in the *Preface*) by imagining the *Globe* to be preſt Flat to the Graduated edge of the *Quadrant of Altitude*, that Flat ſhall be a *South Plain*, and the number of Degrees the *Meridian* Cuts in the *Quadrant of Altitude*, numbered from the *Zenith* Downwards, ſhall be the number of Degrees that each Hour Line ſhall be diſtant from the *Meridian* or Noon-line in a Circle of 360 Degrees, and Lines drawn from the Center of that Circle through thoſe Degrees, ſhall be the Hour Lines of Half the Day: The Hour Lines for the other Half of the Day, are of the ſame diſtance from the Noon-line, with theſe; only they muſt be placed on the other ſide the Noon-line.

If your Plain be not *Direct*, but *Declines Eaſt* or *Weſt*, you muſt number the *Declination Eaſtwards* or *Weſtwards* reſpectively, in the Degrees of the *Horizon*, and (the *Quadrant of*

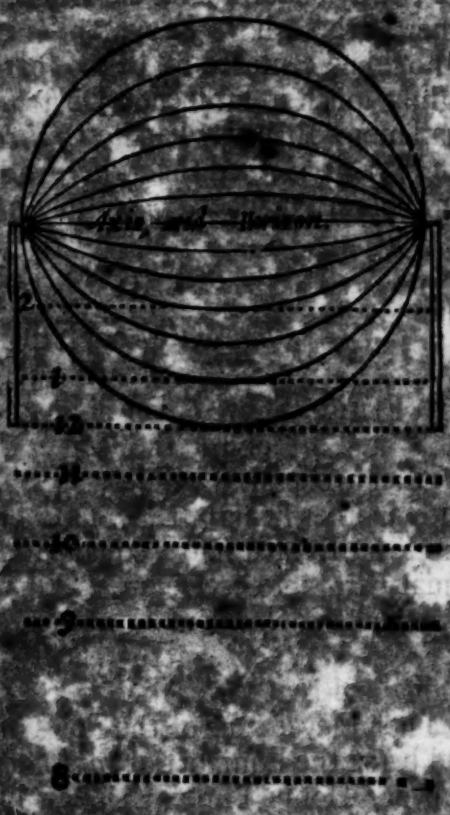
*Altitude*

*Altitude* ſcrewed to the *Zenith*, (as aforeſaid,) bring the lower end of the *Quadrant of Altitude* to the ſaid degrees of *Declination*, and the number of degrees cut by the *Meridians* in the *Quadrant of Altitude*, (numbred downwards,) is the number of degrees that the Hour-Lines are diſtant from the Noon-Line, in a Circle of 360 degrees: And Lines drawn from the Center of that Circle through thoſe deg. be the Hour-Lines of half the Day. And if you turn about the *Quadrant of Altitude* upon the *Zenith* Point, till the lower end of it come to the deg. of the *Horizon*, oppoſite to the deg. of *Declination* found before, the *Meridian* Lines on the *Globe*, (as before,) ſhall cut the *Quadrant or Altitude* in the number of degrees (counted downward,) that each Hour-Line is diſtant from the other ſide the Noon-Line: And Lines drawn from the Center of that Circle through thoſe degrees, ſhall be the Hour-Lines of the other half of the Day.

If your Plain *Decline*, and alſo *Recline* or *Incline*, you muſt uſe the *Gnomonical Semi-Circle*, deſcribed in Prob. 12. which muſt be Elevated on the *Quadrant of Altitude*, when it is ſet to the *Declination* (as by the former Rule,) according to the Complement of *Reclination*, or *Inclination*. But if your Plain be *Direct*, and *Recline*, or *Incline*, it muſt be ſet to the *Meridian*, and the *Meridians* on the *Globe*, ſhall cut that Semi-Circle in the number of degrees counted from the *Quadrant of Altitude*, if the Plain *Decliner*, or from the *Brazen Meridian*, if it be *Direct*, that the ſeveral Hour-Lines are diſtant from a Line Perpendicular to an Horizontal Line, in a Circle divided into 360 Degrees: And Lines drawn from the Centre through thoſe degrees, ſhall be the Hour-Lines of ſuch *Reclining* or *Inclining* Plains.

If your Plain be an *Eaſt* or *Weſt*, either *Direct* or *Declining*; or an *Equinoctial* Plain (for they are upon the matter all one,) you may better conceive how they are to be made, then make them by the *Globe*. And for the help of your Fancy herein, take Mr. *Blagrave*'s Conceit, who in his Book 6. Chap. 8. very properly demonſtrates the Rules for projecting the Hour-Lines on theſe Plains. He propoſes to take 12 Wyers bowed into exact Circle, all of equal Diameter, and ſet together at equal diſtance one from another, in two oppoſite Points, as in two Poles, and to have a ſtraight Line to paſs from one Pole to another, as an *Axis*. Theſe 12 Wyers ſhall repreſent 24 *Meridional* Semi-Circles; Or indeed, they may repreſent the *Globe* it ſelf, containing 24 *Meridional*

ridional Semi Circles to be described on the *Globe*, as aforesaid; and if you place the *Horizon* of the *Globe Horizontal*, and the *North* and *South* Points of the *Globe*, towards the *North* and *South* Points in *Heaven*, and bring one of these Wyer *Meridians* directly under the *Brazen Meridian*, and the *Axis* of this Wyer-*Globe*, in the Plain of the Horizon, and fasten a Thread in the middle of the *Axis*, that Thread drawn from the middle of the *Axis* by every one of these Wyers, shall, if prolonged till it touch an *East* and *West* Line, drawn directly Under, or Over the Points *Zenith* or *Nadir*, point out on that East and West Line, the distances of each Hour-line from the 12 a Clock Line; and Lines drawn at Right Angles through that *East* and *West* Line, shall be the Hour-Lines of an *East* or *West* Plain, or of an *Equinoctial* Plain.




The moving this Thread from Wyer to Wyer, represents the Motion of the *Sun*, which as it passes over all the *Meridians*, causes the Shadow of that Meridional Semi-circle which it is directly Over, and the *Axis*, and the Meridional Semi-circle directly Opposite to the Upper Meridional Semi-circle, to fall all into one straight *Line*; and upon what Point in the *East* and *West* Line (mentioned before,) that Shadow-line shall fall, is marked out by the Application of the Thread, as aforesaid; and is an Hour-line on any of the aforesaid Plains.

If you understand this Probleme rightly, you already know how to draw the Hour-lines upon all manner of *Plains*, and need no further Instructions, yet partly fearing a young Student should not

not clearly understand these Rules, and partly doubting (because other Authors have been more Copious upon this Subject) that I should be censured to be too sparing of my Pains, if I should lightly touch so Eminent a Doctrine as *Dialling* is: Therefore I shall more distinctly handle *Dialling* by the *Globe*, according to the Way or Method that other Authors have Used, and that after so plain a manner, as possibly my Genius can devise.

## PROB. II.

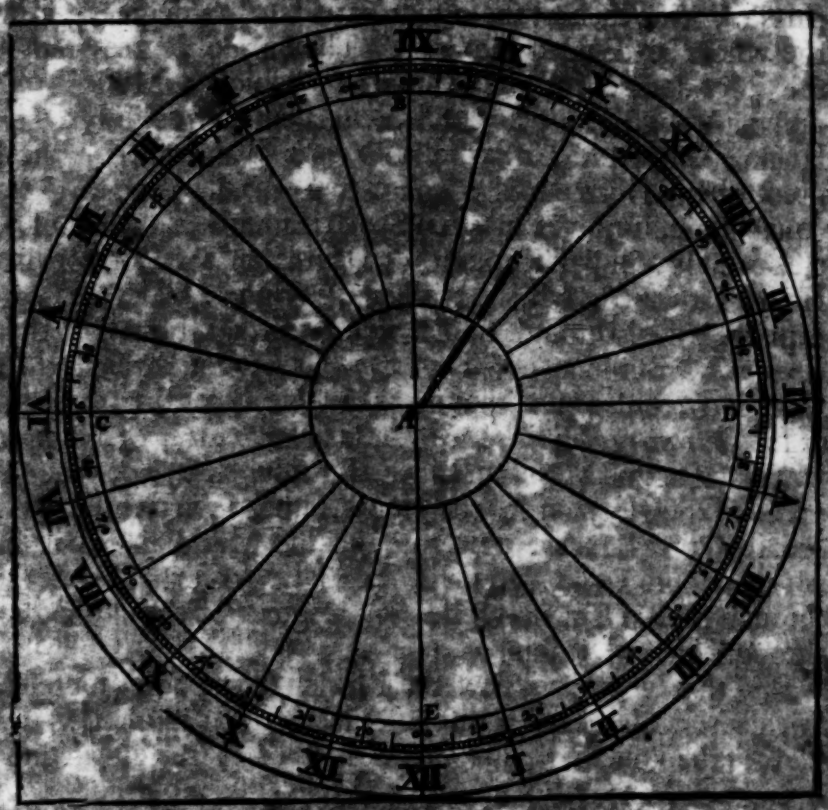
### *To make an* Equinoctial Dial.

DEscribe a Circle, on a Square Board or Plain, as BCED, and through A, the Center thereof, draw a straight Line Parallel to one of the Sides, as B E; cross that straight Line with another straight Line, as C D at Right Angles; so shall the Circle be divided into 4 equal parts. Divide each of these four equal parts into 90 Degrees, as in the Figure. This Circle shall represent the Horizon.

Erect a Wyer exactly perpendicular to the Center of the Plain, and that Wyer shall be the *Gnomon*, or *Style* of the *Dial*.

Then Elevate one of the Poles of your *Globe* into the *Zenith*, and bring the Equinoctial *Colure* to the Meridian. And because in every Hours Time, 15 degr. of the Equator passes through the Meridian in Heaven, therefore turn the *Globe* till 15 *Degr.* of the Equator passes through the Meridian of your *Globe*; so shall the *Colure* pass by 15 *Degr.* of the Horizon also. Therefore from the Center of your Plain, draw straight Lines through 15 *Degr.* from one of the Semi-diameters both ways, and those straight Lines shall be two Hour-Lines. Then turn the *Globe* till 15 *Degrees* more of the Equator pass through the Meridian, and you will find, as before, the *Colure* pass by 15 *Degr.* more of the Horizon; therefore on your Plain, number 15 *Degrees* further, beyond both the former *Lines*, and from the Center draw straight Lines through both those 15 *Degrees*, and they shall be two Hour-Lines more. For all the other Hour-Lines, turn the *Globe* till 15 *Degrees* of the Equator, at a time pass through the *Meridian*, as before, and you will find, that for every 15 *Degr.* of the Equator that passes through the Meridian, the *Colure* will pass through 15 *Degrees* of the Horizon: Therefore those

Hour-Lines muſt be drawn from the Centre, according to the Succeſſion of every 15 *Degrees* on your *Plain*. Having drawn the Hour-Lines, you may ſet Figures on them, beginning to number your Hour-Lines from one of the Diameters, marking it with XII, and the next Hour-Line to the Left Hand with I, and the next II, the next III, *&c.* to XII: And begin again with I, II, III, *&c.* till you come to the other XII, where you began; and then your *Dial* is finiſhed. See the *Figure*.




This is an *Univerſal Dial*, and ſerves in all *Latitudes*; therefore when you place it, you muſt ſet one of the XII's downwards, and the *Axis* Parallel to the *Axis* of the *World*.

But note, both *Faces* of this *Dial* ought to to be divided, and the *Gnomon* muſt appear on both Sides, like the Stick in a Whirligig, which Children uſe; or elſe you muſt turn it upſide down, ſo oft as the *Sun* paſſes the *Equinoctial*.

PROB.

## PROB. III.

### *To make an* Horizontal Dial.

DEſcribe a Circle on your Plain, as CBDE, and through the Center A of that Circle draw a Meridian, (or Twelve a Clock Line) as BE; croſs that Line at Right Angles, with another Line, as CD; ſo ſhall your Circle be divided into four equal parts; divide each of theſe four parts into 90 degrees; ſo ſhall the whole be divided into 360. Theſe 360 degrees repreſent the 360 degrees of the Horizon, which a Meridian Line drawn through the place of the *Sun*, runs through in every 24 Hours: The Motion of which *Meridian* Line through the Degrees of the Horizon, is Regular in a Parallel Sphere; for in equal Time, it moves an equal Space throughout the whole Circle, *viz.* it will paſs through 15 Degrees of the Horizon in one Hours Time, (or which is all one,) whiles 15 Degrees of the Equator paſſes through the *Meridian*, as was ſhewed in the laſt *Probleme*: But in an *Oblique Sphere*, its Motion through the Horizon is Irregular, and that more or leſs, according to the more or leſs *Obliquity of the Sphere*; for far *Northwards* or *Southwards* you may ſee this Meridian Line paſs through 40, 50, yea, 60 degrees of the Horizon in one Hours Time, *viz.* whiles 15 Degrees of the Equator paſs through the Meridian; but in another Hours Time, you will ſcarce have 4 or 5 Degrees paſs through the Horizon, whiles 15 Degrees of the Equator paſs through the Meridian.

But that you may know the Motion of the *Sun* (repreſented by this Meridian Line,) through the Horizon in all *Latitudes*; Elevate the Pole to the *Elevation* of your Place, and chuſe inſtead of a Meridian Line through the Place of the *Sun*, the *Vernal Colure* to be your Meridian Line; both becauſe it is moſt viſible, and becauſe from thence the degrees of the Equator are begun to be numbered, ſo that whatſoever Decimal Degree of the Equator you light on at the Meridian, or elſewhere, you will find its number from that *Colure* already ſet down to your Hand, without either Adding to, or Subtracting from it. Bring this *Colure* therefore to the Meridian, and the Index of the Hour Circle to 12 in the Hour Circle. Then turn the *Globe Weſtwards*

*Westwards*, and so oft as 15 degrees of the *Equator* passes through the *Meridian*, so oft you must examine what degree of the *Horizon* the *Vernal Colure* cuts; and those degrees and minutes so cut by the *Vernal Colure*, must be found in the Circle CBDE, beginning your Account or Reckoning at B towards D, and markt with Pricks; through which Pricks, you must draw Lines from the Center A, and those Lines shall be the Hour-Lines Afternoon. Then bring the *Colure* to the *Meridian* again, to find the Forenoon Hour-Lines, and turn the *Globe Eastwards*, and so oft as 15 degrees of the *Equator* passes through the *Meridian*; so oft you must examine what degrees of the *Horizon* the *Vernal Colure* cuts; and those degrees and minutes so cut by the *Vernal Colure*, must be found in the Circle CBDE, beginning your reckoning from B towards C, and markt with Pricks: Through which Pricks you must draw Lines from the Center A, and those Lines shall be the Forenoon Hour-Lines.

These Hour-Lines must be markt from the *Meridian* Line, *viz.* the Line A B, which is the 12 a Clock Line towards D, with I, II, III, *&c.* till you have numbred to the Hour of *Sun*-set (found by Prob. 7. of the Second Book,) the Longest Day, and from the *Meridian* Line towards C with XI, X, IX, *&c.* till you have numbred to *Sun*-rising the Longest Day.

The *Style* must be placed in the Center, and Elevated so many degrees above the Plain, as the Pole is Elevated above the *Horizon* of the Place.

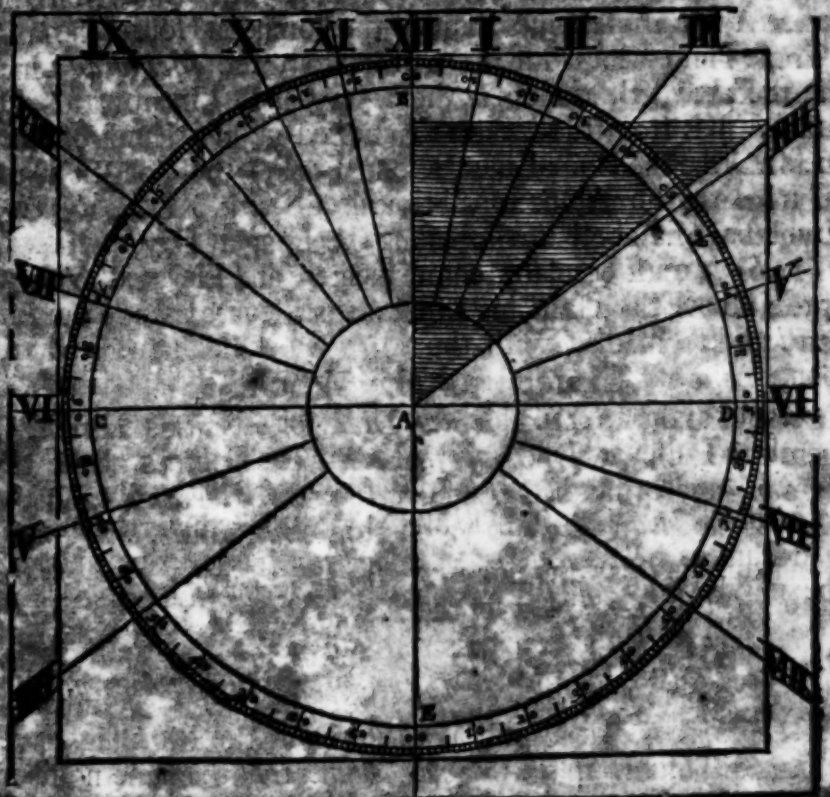
## Example of the Whole.

I would make an *Horizontal Dial* for *London*'s *Latitude*: Therefore I Elevate the *North Pole* 51½ Degrees above the *Horizon*, and bring the *Vernal Colure* to the *Meridian*, and the *Index* of the *Hour-Circle* to 12 on the *Hour-Circle*.

| | | | | |
|---|---|---|---|---|
| And turning the *Globe Westwards*, till the *Index* points to | 1 | a Clock, or till 15 deg. of the *Equator*; pass through the *Meridian*; I find the *Colure* cut the *Horiz.* in | 11.40 | from the *Meridian*. |
| | 2 | | 24.15 | |
| | 3 | | 38. 4 | |
| | 4 | | 53.36 | |
| | 5 | | 71. 6 | |
| | 6 | | 90. | |

These are the distances of the Hour-Lines from Noon till 6 at Night; and to these distances on the Plain (counting from B towards

wards D,) I make Pricks, and from the Center I draw Lines through theſe Pricks; and theſe Lines are the Hour-Lines from 12 to 6 Afternoon. But the *Sun* in the Longeſt Day ſhines till paſt 8 at Night, as you may find by Prob. 48. of the Second Book; therefore here wants the two Evening Hour-lines; which tho' they may be found after the ſame way I found the former, (*viz.* by continuing the turning the *Globe Weſtwards*,) yet, that I may the ſooner reduce my *Work* to the *Plain*, I count the number of *Degrees* between the 7 a Clock Line and the 5 a Clock Line in the Circle on the *Plain*; for the ſame number of *Degr.* counted from D towards E, is the diſtance of the 7 a Clock Hour-Line from the 6 a Clock Hour-Line; and the number of *Degr.* contained between the 6 a Clock Hour-Line and the 4 a Clock Hour-Line, is the diſtance of the 8 a Clock Hour-Line from the 6 a Clock Hour-Line.




Or, I need not draw the 7 and 8 a Clock Hour-Lines, till I have drawn the Forenoon Hour-Lines; for then, by laying the

the edge of a Ruler (that will reach through the opposite side of the Plain,) to the Morning 7 and 8 a Clock Hour-Lines, I may by the side of that Ruler, draw Lines from the Center through the opposite side of the Plain, and those Lines shall be the 7 and 8 a Clock Hour-Lines Afternoon.

Having thus all the Afternoon Hour-Lines, I bring the *Vernal Colure* to the *Meridian* again; so shall the *Index* again point to 12. Therefore, as before, I turned the *Globe Westwards*; so now

| | | | | |
|---|---|---|---|---|
| turning it | 11 | a Clock, or till 15 | 11.40 | |
| *Eastwards*, | 10 | deg. of the *Equator* | 24.15 | |
| till the *In-* | 9 | pass through the | 38. 4 | from the |
| *dex* points | 8 | *Meridian*, I find | 53.36 | *Merid.* |
| to | 7 | the *Colure* Cut the | 71. 6 | |
| | 6 | *Horizon* in | 90. | |

These are the distances of the Hour-Lines from Noon to 6 a Clock in the Morning; and these distances, I seek in the Circle of the Plain, (counting from the Noon-Line B towards C,) and mark them with Pricks; through which Pricks (as before,) I draw Lines from the Center to the outside Plain; and those Lines shall be the Hour-Lines.

Or, having the distance of all the Afternoon Hour-Lines, I have also the distance of all the Forenoon Hour-Lines from the *Meridian*; as you may see, by comparing the two former Tables: For the 1 a Clock Hour-Line Afternoon, is equidistant from the *Merid.* or Noon-Line, with the 11 a Clock Hour-Line before Noon, *viz.* they are both 11 deg. 40 minutes distant from the Noon-Line, and the 2 a Clock Hour-Line Afternoon, is from the Noon-Line, equidistant with the 10 a Clock Hour-Line Beforenoon; for they are both 24 deg. 15 minutes distant from the *Merid.* or Noon-Line; and so all the other Morning Hour-Lines are distant from the Noon-Lines, by the same space that the same number of Afternoon Hour-Lines (told from the *Meridian* on the contrary side the Noon-Line,) are distant from *Meridian*.

Whence it follows, that since (as aforesaid) the same number of Hour-Lines after 6 at Night, and before 6 in the Morning, have the same distance from the 6 a Clock Line, that the same number of Hour-Lines before 6 at Night, and after 6 in the Morning, have from the 6 a Clock Line; and since the same number of Hour-Lines

Lines before Noon are equidistant from the *Meridian* or Noon Line by the same space of Degrees that the same number of Hour lines Afternoon are, it follows (I say) that having found the distance of the Six Hour-lines either before or after Noon, you have also given the distance of all the other hour-lines.

If you will have the half Hour-lines placed on your *Dyal*, you must turn the *Globe* till the *Index* points to every half Hour in the Hour-circle, as well as to the whole, and examine the Degrees of the *Horizon* Cut by the *Vernal Colure*, as you did for the whole Hours; and in like manner transfer them to your *Plain*.

Having thus drawn all the Hour-lines, I count from the Noon-line 51½ Degrees, the Elevation of the *Pole* here at *London*; and from the Center A, I draw a straight Line, as A F through these 51½ Degrees for the *Gnomon* or *Style*, and prolong it to the farthest extent of the *Plain*: From this *Gnomon* or *Style* I let fall a Perpendicular upon the Noon-line as F G (this Perpendicular is called the *Substyle*) and this Perpendicular and its Base (which is the Noon-line) and Hypothenusa (which is the *Gnomon*) shall make a Triangle, which being erected upon the Base, so as the *Substyle* may stand Perpendicular to the *Plain*, the Hypothenusa A F shall be the *Gnomon*, and be Parallel to the *Axis* of the *World*, and cast a shadow upon the Hour of the Day.

## PROB. IV.

### *To make an* Erect Direct South Dyal.

DRaw on your *Plain* an *Horizontal* Line as C A D, as was shewed in the *Preface*: In the middle of this Line (as at A) describe as on a Center the Semi-circle C B D: From the Center A let fall a Perpendicular, which shall divide the Semi-Circle into two *Quadrants*, each of which *Quadrants* you must divide into 90 Degrees. Then Rectifie the *Globe*, *Quadrant of Altitude*, *Colure* and *Hour-Index*, thus, Elevate the *Pole* of the *Globe* to the *Latitude* of your place, and screw the *Quadrant of Altitude* to the *Zenith*. Then bring the *Vernal Colure* to the *Meridian*, and the *Index* of the *Hour-circle*, to the Hour of 12 in the *Hour-circle*, so shall your *Globe*, *Quadrant of Altitude*, *Colure*, and *Hour-Index* be Rectified. And thus you must always Rectifie them for the making of most sorts of *Dyals* by the

*Globe.* Then to make an *Erect Direct South Dyal*, Bring the lower end of the *Quadrant of Altitude* to the *West* Point of the *Horizon*; and turn the *Globe Westwards* till the Index points to all the Hours Afternoon; and examine in what numbers of Degrees from the *Zenith* the *Colure* Cuts the *Quadrant of Altitude* when the *Index* Points to each Hour: for a Line drawn from the Center A through the same number of Degrees reckoned from the Perpendicular A B (which is the 12 a Clock Line) towards D on the *Plain*, shall be the same Hour-Lines the *Index* points at.

Thus in our *Latitude*, *viz.* 51½ Degrees the *Vernal Colure* being brought to the *Meridian* and the *Index* to 12,

| If you turn the *Globe Westwards*, till the *Index* Points to | | | | counted from the *Zenith*. |
|---|---|---|---|---|
| 1 | 1 Clock, or till | 15 | 9. 18 | |
| 2 | Deg. of the *Equator* | 19 | 11. 5 | |
| 3 | *or* pass through | 32. 5 | | |
| 4 | the *Meridian*, the | 48. 0 | | |
| 5 | *Colure* will Cut | 67. 4 | | |
| 6 | the *Quad. of Alt.* in | 90. | | |

And these are the distances of the afternoon Hour lines, which you must transfer to the *East* side of your *Plain*, *viz.* from B towards D; and draw Lines from the Center A through these distances; and these Lines shall be your After Noon Hour-Lines.

Note (once for all) when the *Colure* goes off that Circle you examine the Hour distances in, the *Sun* will Shine no longer upon that Plain; as in this example, the *Colure* goes off the *Quadrant of Altitude* at 6 a Clock, therefore the *Sun* will not Shine longer than till 6 a Clock upon this Plain.

The Hour-Lines before Noon have the same distance from the *Meridian* that the After Noon Hour-Lines have, as was shewed in the last Problem: Only they must be counted from B towards C, and drawn on the *West* side the Noon-Line.

*Otherwise.*

You may reduce all *Verticals* into *Horizontals*; if you Elevate the *Pole* of the *Globe* to the *Complement* of the *Latitude* of your Place; and bring the *Vernal Colure* to the *Meridian* under the *Horizon*, and the *Index* of the *Hour Circle* to 12; and turn

the *Globe Westwards*, for as the *Index* passes through every Hour on the *Hour-circle*, the *Colure* shews in the *Horizon* the distance of the several Afternoon Hour-lines from the *Meridian* or 12 a Clock-line, in the *Circle* on your *Plain*, numbred from B to D: And Lines drawn from the Center through these distances on your *Plain*, shall be the Afternoon Hour-lines of your *Dyal*.

*Example.*

*London*'s Latitude is $51\frac{1}{2}$ Degrees, its *Complement* to 90 is $38\frac{1}{2}$. Therefore I Elevate the *Pole* $38\frac{1}{2}$ Degrees above the *Horizon*, and bring the *Vernal Colure* to the *Meridian* under the *Horizon*, and the *Index* of the Hour-*circle* to 12 on the Hour *Circle*. Then

| | | | | |
|---|---|---|---|---|
| Turning the *Globe Westwards*, till the *Index* points to | 1 | a Clock: or till 15 Deg. of the *Equator* pass through the *Meridian*; find the *Colure* Cut the *Horizon* in | 9 18 | from the intersection of the *Meridian* and the *Horizon*, as in the former Table. |
| | 2 | | 19. 15 | |
| | 3 | | 32. 5 | |
| | 4 | | 48. 0 | |
| | 5 | | 67. 0 | |
| | 6 | | 90. | |

And these are the distances of the 6 Hours-lines from the *Meridian*; as you may see in this Figure.

By this *Example* you may see it is easy to reduce *Verticals* into *Horizontals*: And *Horizontals* into *Verticals*: For this *Erect Direct South Dyal* is an *Horizontal Dyal* to those People that Inhabit 90 Deg. from Us, *viz.* in the *South Latitude* of $38\frac{1}{2}$ Deg.

Then make a Triangle, whereof the Noon Line shall be

Base: From it count the *Complement* of the *Poles Elevation*, viz. 38½ Degrees, and through them draw the Line A F, from the Center A, which shall be the Hypothenusa; then let fall a Perpendicular upon the Noon Line A B, so is your Triangle made. If this Triangle be erected perpendicularly upon the Base or Noon Line, the Hypothenusa A F shall stand parallel to the *Axis* of the *World*, and cast a Shadow upon the Hour of the Day.

## PROB. V.

### *To make an* Erect Direct North Dyal.

IF the *Erect Direct South Dyal* were turned towards the *North*, and the Line C A D were turned downwards, and the Line marked with 7 be now marked with 5, and the Line 8 with 4, and the Line 5 with 7, and the Line 4 with 8, then have you of it a *North Erect Direct Dyal*.

All the other Hour Lines in this *Dyal* are Useless, because the *Sun* in our Latitude Shines on a *North Face* the longest Day only before 6 in the Morning, and after 6 at Night.

## PROB. VI.

### *To make an* Erect Direct East Dyal.

THese sorts of *Dyals* may better be demonstrated than made by the *Globe*; unless the *Axis* of your *Globe* were accessible, as in the *Wyer-Globe*, specified in Prob. 1. of this Book; therefore when you would make an *East* or *West-Dyal*, or a *Polar-Dyal*.

Provide a square Board; as A B C D, draw the straight Line *e f* upon it parallel to the sides A C, and B D, and just in the middle between them: Cross this straight Line at Right Angles with another straight Line, as *g h*, quite through the Board.

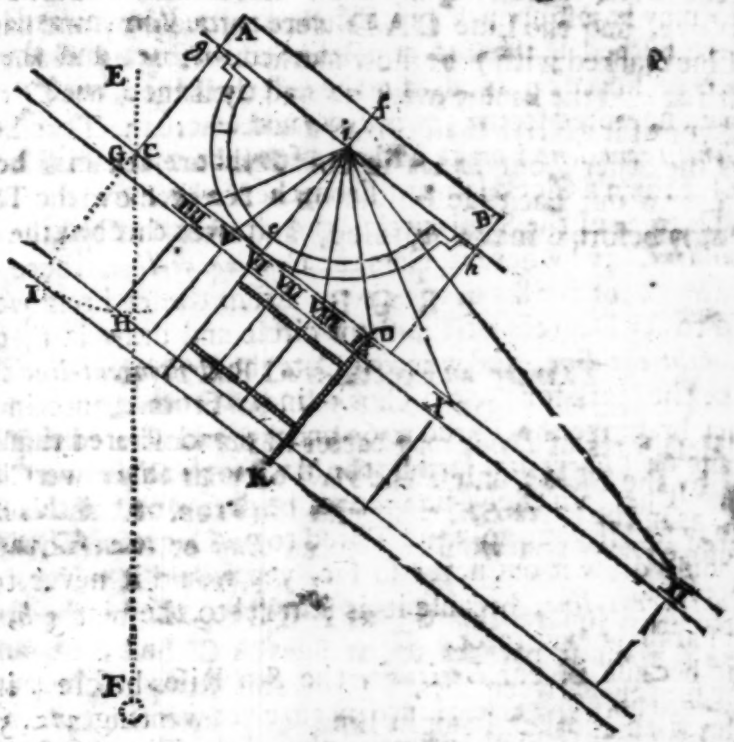
Upon this Board with a little Pitch or Wax fasten the Semi-*Circle of Position*, so as both the *Poles* thereof may lie in the Line *g h*, and the middle of the Semi-Circle marked 00 may lie upon the Line *e f* so shall *i* be the Center of the Semi-*Circle of Position*;

in

In this Center make a ſmall Hole through the Board, fit to receive a Wyer or a Nail: So may you with the *Circle of Poſition* thus fitted, and the ſide C D applied to a Line of *Contingence* Elevated to the Height of the *Equinoctial*, draw Lines from the Center through every 15 Degrees of the *Circle of Poſition*, and by continuing them interſect the Line of *Contingence* in the points from whence the Hour Lines of an *Eaſt* or *Weſt Dyal* is to be drawn.

*Example.*

I would make an *Erect Direct Eaſt Dyal* for *London*'s *Latitude*. Therefore I faſten a *Plumb-line* a little above the place




on the Wall where I intend to make my *Dyal*, and wait till it Hangs quietly before the Wall; Then if the Line be rubbed with Chalk (like a *Carpenters* Line) I may by holding the *Plumbet* end cloſe to the Wall, and ſtraining it pretty ſtiff, ſtrike with it a ſtraight

ſtraight line as *Carpenters* do. This line ſhall be a Perpendicular as E F: I cauſe a convenient point in this Perpendicular, as at G, for a Center: Whereon I deſcribe an occult Arch as H I; this Arch muſt contain the number of Degrees of the Elevation of the *Equinoctial* counted between H and I, (which in our *Latitude* is 38½.) Therefore in a *Quadrant* of the ſame *Radius* with the occult Arch I meaſure 38½ Degrees, and ſet them off in the *Plain* from H in the Perpendicular to I: Then from I to the Center G in the Perpendicular, I draw the Prick-line I G, and this Line ſhall repreſent the *Axis* of the *World*: I croſs this *Axis* at Right Angels with the Line G K, and draw it from G to K, ſo long as I poſſibly can: This Line ſhall be the *Contingent-line*. I find a convenient place in this *Contingent-line*, as at V I, to which I apply the ſide of the Board C *e* D, ſo as that the point *e* may ly juſt upon V I in the *Contingent-line*; and having a Thred faſtned in the Center of the Semi-*circle of Poſition*, I draw that Thred ſtraight over the firſt 15 Deg. of the *Circle of Poſition*, numbred from *o* towards *h*, and where the Thred Cuts the *Contingent-line* I make a Mark, for that Mark ſhall be the Mark for the 7 a Clock Line. From thence I remove the Thred to 30 Degrees of the Semi-circle, and draw it through the *Contingent-line*, and where it Cuts the *Contingent-line*, there ſhall be the Mark for the 8 a Clock-line. From thence I remove the Thred to 45 Degrees of the Semi-circle and draw it through the *Contingent-line*, and where it Cuts the *Contingent-line* there ſhall be the Mark for the 9 a Clock-line. From thence in like manner I remove the Thred to 60 and 75, and where the Thred Cuts the *Contingent-line* ſhall be the Mark for 10 and 11 a Clock-Lines. The 12 a Clock-line cannot be drawn on this *Plain*, as you may ſee, if you apply the Thred to 90 Degrees, for though you ſhould draw it out never ſo far, yet would it never touch the *Contingent-line*, becauſe it is Parallel to the Line *g h*, and Lines Parallel never meet.

But becauſe in our *Latitude*, the *Sun* Riſes before 4 in the Morning, therefore two Hour-lines are yet wanting, *viz.* 5 and 4, which I may find either by applying the Thred firſt to 15, and next to 30 Degrees from *o* towards *g* in the Semi-circle, and ſo Marking where it Cuts the *Contingent-line*, as before: Or elſe by transferring the diſtance of the ſame number of Hour-Lines from the 6 a Clock-line already drawn on the ſide *e h*, to the ſide *e g*, as in Prob. 2. of this Book is more fully ſhewed.

Having

Having thus Marked out on the *Contingent-line* the diſtances of each Hour, I draw a Line parallel to the *Contingent-line*, and draw Lines from every Hour Markt on the *Contingent* to croſs the *Contingent-line* at Right Angles, and continue each Line to the Line parallel to the *Contingent*; and theſe Lines ſhall be the Hour Lines of an *Eaſt Plain*. To theſe Hour Lines I ſet Figures, as in the *Scheme* may be ſeen.

The *Style* DK of this *Dyal* (as well as of others) muſt ſtand parallel to the *Axis* of the *World*: It muſt be alſo parallel to all the Hour Lines, and ſtand directly over the 6 a Clock Line, and that ſo high as in the diſtance between the Center of the Semi-*Circle of Poſition* and the point where the 6 a Clock Line Cuts the *Contingent-line*: Or (which is all one) at ſuch an Height as when it is laid Flat down upon the *Plain* it may juſt reach the 9 a Clock Line.

## PROB. VII.

### *To make an* Erect Direct Weſt Dyal.

AN *Erect Direct Weſt Dyal* is the ſame in all reſpects with an *Erect Direct-Eaſt Dyal*; only as the *Eaſt* ſhews the Fore-noon Hours, the *Weſt* ſhews the Afternoon-Hours.

Thus if you ſhould draw the *Eaſt Dyal* on any tranſparent *Plain*, as on Glaſs, Horn, or an oyled Paper, on the one Side will appear an *Eaſt Dyal*, and on the other a *Weſt*; only the Figures (as was ſaid before) muſt be changed; for that which in the *Eaſt Dyal* is 11, in the *Weſt* muſt be 1: that which in the *Eaſt Dyal* is 10, in the *Weſt* muſt be 2: that which in the *Eaſt Dyal* is 9, in the *Weſt* muſt be three: *&c.*

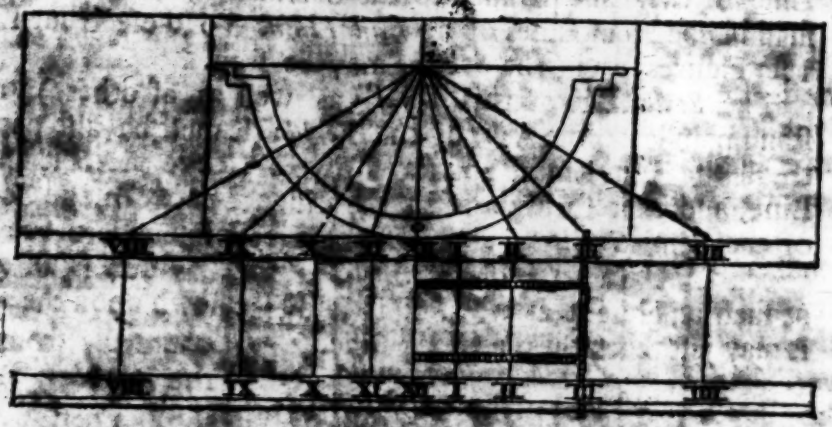
## PROB. VIII.

### *To mark a* Polar Dyal.

*Polar Dyals* are *Horizontal Dyals* under the *Equinoctial*: They are of the ſame kind with *Eaſt* and *Weſt Dyals*; Only whereas *Eaſt* and *Weſt Dyals* have but the Hour Lines of Half the Longeſt Day deſcribed on them, theſe have all the Hour Lines

Lines of the whole Day; and are marked on both sides the Noon Line; as in the following Figure.

The *Style* of this *Dyal* must stand over the Noon Line, Parallel to the Plain; for then it will also be Parallel to the *Axis*



of the *World*: And its Height above the *Plain* must be the distance between the Center of the Semi-Circle and the point in the *Contingent-Line* Cut by the Noon-Line. But I have inserted the Figure, which alone is sufficient instructions.

## PROB. IX.

*To make* Erect South Dyals, Declining Eastwards *or* Westwards.

Draw on your *Plain* an *Horizontal-line*, and on it describe a Semi-circle, as you were taught in Prob. 4.

Then Rectifie the *Globe*, *Quadrant of Altitude*, *Colure*, and *Hour-Index*, as by the same Probleme: And bring the lower end of the *Quadrant of Altitude* to the Deg. of Declination from the *North* point in the *Horizon Eastwards* or *Westwards*; for then the *Quadrant of Altitude* shall represent a *Plain Declining* from the *North Eastwards*, or *Westwards* accordingly. Then turn the *Globe Eastwards*, till the *Index* of the *Hour-circle* points to all the Hours before Noon, and examine in what number of Degrees from the *Zenith* the *Colure* Cuts the *Quadrant of Altitude*, when the *Index* points to each Hour, for a Line drawn from the Center A through the same number

ber of Degrees reckoned from the Perpendicular A B, which is the 12 a Clock Line towards C on the *Plain*, ſhall be the ſame Hour Lines the Index points at.

*Example.*

I would make an *Erect Dyal Declining* from the *North* towards the *Eaſt* 63 Degrees: The *Globe*, *Quadrant of Altitude*, *Vernal Colure*, and *Hour Index* Rectified, as before I bring the lower end of the *Quadrant of Altitude* to 63 Degrees counted from the *North* Point of the *Horizon* towards the *Eaſt*: Then

| | | | | |
|---|---|---|---|---|
| I turn the *Globe Eaſtwards* till the *Index* points to | 11 | a Clock: or till 15 Degrees of the *Equator* paſs through the *Meridian*, and find the *Colure* Cut the *Quadrant of Altitude* in | 9.43 | counted from the *Zenith*. |
| | 10 | | 19. 0 | |
| | 9 | | 25.57 | |
| | 8 | | 35.10 | |
| | 7 | | 45.56 | |
| | 6 | | 60.15 | |
| | 5 | | 79.45 | |

And theſe are the diſtances of the Fore-noon Hour-lines which I ſeek in the *Weſt*-ſide of the *Plain*, *viz.* from B towards C; and through theſe diſtances I draw Lines from the Center, and theſe Lines ſhall be the Fore-noon Hour-lines.

Now herein is a difference between *Declining Dyals*, and *Direct Dyals*; For having found the diſtances of the Hour-lines for one Half of the Day, be it either for Before-noon, or After-noon in a *Direct Dyal*, you have alſo found the diſtances for the other Half Day; becauſe, as was ſaid, Prob. 3. Equal number of Hours have equal diſtance from the Noon-line: But in *Declining Dyals* it is not ſo; becauſe the *Sun* remaining longer upon that ſide of the *Plain* which it *Declines* to, than it doth upon the contrary Side, there will be a greater number of Hour-lines upon it, and by conſequence the diſtance of the Hour-lines leſs than on the contrary Side of the *Plain*.

Therefore for finding the After-noon Hour-lines, I turn about the *Quadrant of Altitude* upon the *Zenith* Point, till the lower end of it come to the Degree of the *Horizon* oppoſite to that Deg. of *Declination* that the *Quadrant of Altitude* was placed at when I ſought the Fore-noon Hour-Lines, *viz.* to 63 Degrees

counted from the *South* toward the *West*, and bring the *Vernal Colure* again to the *Meridian*, and the *Index* (as before) to 12. Then,

turning the *Globe Westwards* till the *Index* points to { 1 2 3 4 } a Clock, or till 15 Deg. of the *Equa.* pass through the *Meridian*. I find the *Colure* Cut the *Quadrant* of *Altitude* in { 11.20 26.47 49.20 75.52 } counted from the *Zenith*.

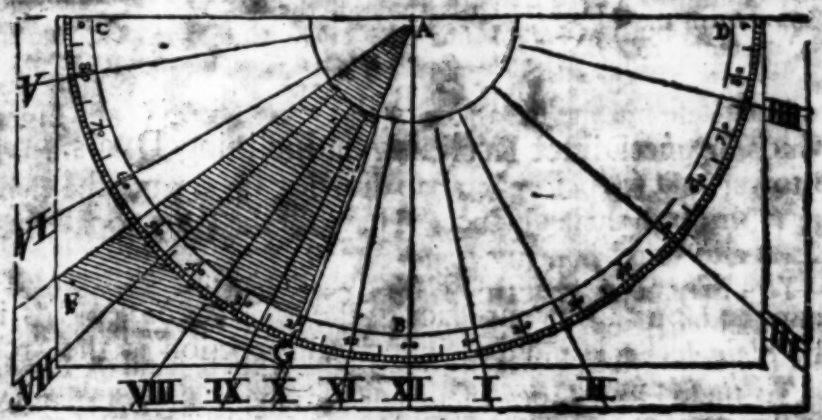
And these are the distances of the After Noon Hour Lines, which distances I seek in the *East* Side of the *Plain*, viz. from B towards D (as before) and so drawing Lines from the Center A through these distances, I have all the Afternoon Hour Lines also drawn on my *Plain*.

You may note, that this *Plain* is capable to receive no more Hour Lines After Noon than 4; for when the *Colure* goes off the *Quadrant of Altitude*, the Sun goes off these kind of *Plains*.

To these Hour Lines I set their Numbers, as you may see in the *Figure*.

Then to find both the distances of the *Substyler* line from the 12 a Clock line, and the Elevation of the *Style* above the *Plain*, Bring the *Colure* to the number of Degrees of the *Plains Declination*, counted in the *Horizon* from the *South* Point to the *East* Point, and the *Quadrant of Altitude* to the Degrees of the *Plains Declination*, counted in the *Horizon* from the *North* Point towards the *East*, so shall the *Quadrant of Altitude* and the *Colure* Cut each other at Right Angles; and the number of Deg. comprehended between the *Colure* and the *Zenith* in the *Quadrant of Altitude*, shall be the number of Degrees between the *Substyler* Line and the 12 a Clock Line, which in this *Example* is 19 Degrees 45 Min. and the number of Degrees comprehended between the *Quadrant of Altitude* and the *Pole*, counted in the *Colure*, shall be the number of Degrees that the *Style* is to be Elevated above the *Plain*, which in this *Example* is 33 Degrees, 40 Min. Wherefore, for the distance of the *Substyler* Line from the 12 a Clock Line, I count in the Circle from the 12 a Clock Line in the contrary side of the *Plain*, *viz.* in the *West* side, because the *Plain Declines* towards the *East*) 19 Deg. 45 Min. as at D, and through that number of Degrees and Min. from the Center A, I draw the Line A G, which shall be the *Substyler* Line: And from the *Substyler* Line (either way) I number 33 Degrees 40 Min. the Elevation of the *Style* above the *Plain*, and through

through theſe Degrees and Minutes I draw from the Center A, the Line A F, for the *Style* or *Gnomon*; Then I let fall the Perpendicular F G upon the *Subſtyle* A G: So is there a Triangle




made, which if it be erected Perpendicular upon the *Subſtyle* A G, the *Style* A F ſhall be Parallel to the *Axis* of the *World*, and caſt a Shadow upon the Hour of the Day.

Here you may ſee that in *Declining Dyals* the *Style* doth not ſtand at the ſame Elevation above the *Plain*, that it doth in *Erect Direct Dyals*; neither doth it ſtand over the 12 a Clock Line, but ſwerves from it towards the Quarter of *Declination*.

## PROB. X.

### *To make a* South Erect Dyal, Declining Eaſtwards *or* Weſtwards.

AS in Prob. 5. an *Erect Direct North Dyal* hath the ſame Declination that an *Erect Direct South Dyal* hath, and differs only in the placing the *Figures* of the Hour Lines: So a *South Erect Dyal* that *Declines Eaſtwards*, or *Weſtwards*, differs from a *North Erect Dyal* that *Declines Eaſtwards*, or *Weſtwards*, the ſame number of Degrees, only in placing the Hour Lines at the ſame diſtance on the contrary Side of the *Plain*, and by tranſpoſing the *Figures* of 11 for 1: 10 for 2: 9 for 3, *&c.*

Thus, if you draw upon Glaſs, Horn, or an Oiled Paper, the *North Dyal Declining Eaſtwards*, as in the foregoing Pro-

bleme, and place it to its due Situation, the Back Side of it ſhall be a *South Dyal Declining* towards the *Weſt* ſo many Degrees as the aforeſaid *Declines* towards the *Eaſt*; and the only difference in it will be the *Figures* of the Hour Lines; as was ſaid before.

## PROB. XI.

### *To make* Direct Reclining *or* Inclining Dyals.

*Direct Reclining* or *Inclining Dyals* are the ſame with *Erect Direct Dyals* that are made for the *Latitude* of ſome other Places: The *Latitude* of which Places are either More than the *Latitude* of your Place if the *Plain Recline*, or leſs if the *Plain Incline*; and that in ſuch a Proportion as the Arch of *Reclination* or *Inclination* of your *Plain* is.

Thus a *Direct South Dyal Reclining* 10 Degrees in *Londons Latitude*, *viz.* 51½ Degrees, is an *Erect Direct Dyal* made for the *Latitude* of 61½ Degrees: And a *Direct South Dyal Inclining* 10 Degrees in the *Latitude* 51½ Degrees, is an *Erect Direct Dyal* in the *Latitude* 41½ Degrees; and is to be made according to the Directions in Prob. 4.

## PROB. XII.

### *To make* Declining Reclining, *or* Declining Inclining Dyals.

THE diſtances of the Hour Lines either for a *Declining Reclining Plain*, or a *Declining Inclining Plain*, may moſt eaſily be found upon the *Plain* of the *Horizon*. That is, (as ſome Authors call it,) by the *Horizontal Dyal*, by changing the Circles of the *Globe* one into another: So as the *Plain* of the *Horizon* may ſerve to repreſent the *Dyal Plain*; Yet this way not being Natural, becauſe you muſt admit one Circle to be another, and that in Young Learners might ſometimes breed a little difficulty, *Gemma Friſius*, *Metius* and *Bleau* have preſcribed a thin Braſs Plate to be made, equal to a *Semi-Circle* of the *Equinoctial*, and divided from the Middle Point of it either way into 90 Degrees, which may not unproperly be called a *Gnomonical Semi-Circle*. This Semi-Circle muſt be bowed

bowed close to the Body of the *Globe* into a Semi-Circular Form, and so set to any *Reclination* or *Inclination*, and then it will represent a *Reclining* or *Inclining Plain*: And by the motion of the *Colure* through the several Degrees of this Semi-Circle the distances of the Hour lines may be found: Thus,

The *Globe Quadrant of Altitude*, *Colure*, and *Hour Index* Rectified; as by Prob. 4. Bring the lower end of the *Quadrant* of *Altitude* to the degree in the *Horizon* of the *plains Declination*, if your *Plain* be a *South Declining Incliner*, or a *North Declining Recliner*, and count on the *Quadrant of Altitude* from the *Zenith* downwards the number of Degrees of *Reclinatin*, or *Inclination*, and to that number of Deg. bring the middle of the *Gnomonical Semi-circle*, and let the ends of it Cut the *Horizon* on either side in the Degrees of the *Plains Azimuth*, so shall the *Gnomonical-Semicircle* represent your *Reclining* or *Inclining Plain*. And so oft as 15 Degrees of the *Equator* passes through the *Meridian*, so oft shall you enquier what Deg. of the *Gnomonical semi-Circle* the *Colure* Cuts; for so many Degrees asunder must the several respective Hour Lines of a *Reclining Declining Plain* be in a Semi-Circle divided into 180 Degrees.

But if your *Plain* be a *South Declining Recliner*, or a *North Decliner Incliner*; Bring the *Quadrant of Altitude* to the Deg. of the *Horizon* opposite to the Degree of the *Plains Declination* (because the Upper side of the *Plain* lies beyond the *Zenith*) counted from the *South* Point in the *South Recliner*: and from the *North* point in *North Incliners*.

Then find the *Height* of the *Style*, and place of the *Substile*: thus, keep your *Gnomonical Semi Circle* in its Position: But turn the *Quadrant of Altitude* about on the *Zenith* point till the Lower end of it comes to the Deg. of the *Horizon* opposite to the Deg. it was placed at before, and turn about the Globe till the *Colure* Cut the *Quadrant of Altitude* above the *Horizon* in the number of Degrees the *Plain Reclines* from the *Zenith*; so shall the *Colure* Cut the *Gnomonical Semi-Circle* at Right Angles; then count the Degrees contianed between the middle of the *Gnomonical Semi-Circle* and the *Colure*, for that number of Deg. is the distance of the *Substile* from a Perpendicular Line in the middle of your *Plain*, and must be placed *Westwards* of the said Perpendicular, if your *Plain decline* from the *South Eastwards*; or *Eastwards*, if your *Plain Decline* from the *South Westwards*

wards. Then Observe how many Degrees are contained betwen the Semi-Circle and the *Pole*; for that number of Degrees is the number of Degrees that the *Style* is to be Elevated above the *Substyle*.

*Example.*

Here at *London*, I would make a *Dyal* upon a *Plain Declining* from the *South Eastwards* 30 Degrees, and *Reclining* from the *Zenith* 20 Degrees; *Londons Latitude* is 51½ Degrees. Therefore, having on the *Plain* described a Semi-Circle, *&c.* as was directed *Prob* 4. I Rectifie the *Globe*, *Quadrant of Altitude*, *Colure* and *Hour Index*, as by the same probleme, and bring the lower end of the *Quadrant of Altitude* to 30 Degrees from the *North* Point of the *Horizon* towards the *VVest*, because that is the Deg. opposite to the Degree of the *Plains Declination*, *viz.* to 30 Degrees from the *South Eastwards*, and I bring the middle of the *Gnomonical Semi-Circle* to 20 Degrees of the *Quadrant of altitude* counted from the *Zenith* downwards towards the *Horizon*, and the ends of the *Gnomonical Semi-Circle*, to the Degrees of *Azimuth* the *Plain* lies in the *Horizon*, *viz.* to 30 Degrees from the *East* Point *Northwards*, and to 30 Degrees from the *West* Point *Southwards*, so shall 11 Degrees 10 Minutes of the *Gnomonical Semi-Circle* be comprehended betwen the *Quadrant of Altitude* and the *Brasen Meridian*: These 11 Degrees 10 Minutes shew that the 12 a Clock Line is distant from the Perpendicular A B 11 Degrees 10 Minutes: Then to find all the Fore-Noon Hour Lines,

| | | | | |
|---|---|---|---|---|
| I turn the *Globe Eastwards* till the *Index* points to | 11 | a Clock; or till 15 Deg. of the *Equator* pass through the *Meridian*; and find the *Colure* cut the *Gnomonical Semi-Circle* in | 15. 8 | counted from the midle of the *Gnomonical Semi-Circle*. |
| | 10 | | 18.56 | |
| | 9 | | 22.37 | |
| | 8 | | 26.52 | |
| | 7 | | 32.37 | |
| | 6 | | 42. 5 | |
| | 5 | | 62.43 | |

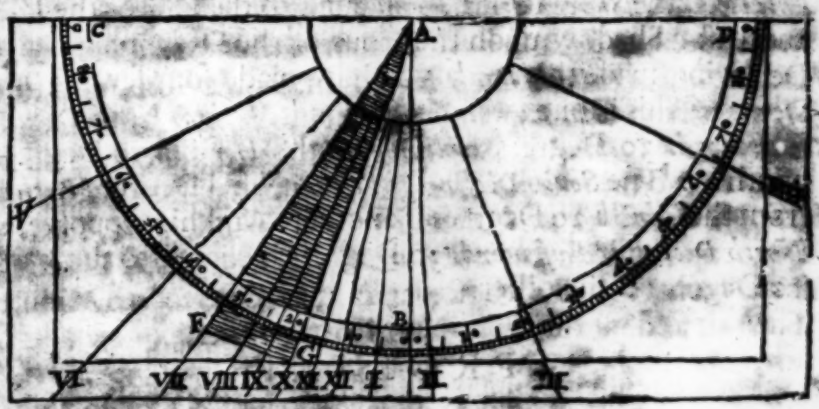
And these are the distances of the Fore-Noon Hour lines; to which distances you may set pricks on the *VVest* side the *Semi-Circle* of the *Plain*, *viz.* from B to C.

The

The After Noon Hour Lines are found by bringing the *Colure* again to the *Meridian*, and the *Index* of the *Hour Circle* to 12. For, then,

| | | | | | |
|---|---|---|---|---|---|
| turning the *Globe* | 1 | a Clock, or till 15 Deg. of | 5.45 | counted from |
| *Weſtwards* till the | 2 | the *Equator* paſs through | 2.54 | the middle of |
| *Index* points to | 3 | the *Merid.* I find the *Colure* | 20.52 | the *Gnomon.* |
| | 4 | Cut the *Gnomon. Semi-Cir.* | 64.36 | *Semi-Circle.* |

And theſe are the diſtances of the After Noon Hour Lines; and muſt all but the 1 a Clock Hour Line be prick'd down at their reſpective diſtances, on the Eaſt ſide the *Plain, viz.* from B to D: But becauſe the *Colure* comes not to the middle of the *Gnomonical Semi-Circle* before the firſt 15 Degrees of the *Equator* paſs through the *Meridian* after 12. Therefore the 1 a Clock muſt ſtand 5 Degrees 45 Minutes on the *Weſt* ſide of the *Plain:* And for this Cauſe I made diſtinction with a Line between the 1 a Clock,




and the 2 a Clock, in the foregoing Table. Then I draw Lines from the Center A, through every one of theſe Pricks in the Semi-Circle, and they ſhall be the Hour Lines of this *Declining Reclining Plain.*

Having drawn the Hour Lines, I remove the *Quadrant of Altitude* to the Degree of the *Horizon*, oppoſite to the Deg. it was at before, *viz.* to 30 Degrees from the *South Eaſtwards*, which is ſo much as the *Plain Declines Eaſtwards*; But I let the *Gnomonical Semi-Circle* ſtand as it did: And turning about the

*Globe*

*Globe* till the *Colure* Cut the *Quadrant of Altitude* in 20 Degrees, Counted from the *Horizon* Upwards; *viz.* the Degrees of *Reclination*, I find 18 Degrees 40 Min. contained between the middle of the *Gnomonical Semi-Circle* and the *Brazen Meridian*, which is the distance of the *Substyle* from the Perpendicular; And I find the *Gnomonical Semi-Circle* Cut the *Colure* in 13 Degrees 49 Minutes from the *Pole*, which is the Heighth that the *Style* must be raised over the *Substyle*; Therefore I Prick off in the Semi-Circle on the *Plain*, the distance of the *Substyle* 18 Degrees 40 Minutes from the Perpendicular *Westward*, because this *Plain Declines Eastwards*: And from the Center A, I draw through that Prick the Line A E, which shall be the *Substyle*, and from this *Substyle* (either way) I count in the Semi-Circle on the *Plain* 13 Degrees 49 Minutes, and there make a Prick: Then from the Center A, I draw through that Prick the Line A F, to represent the *Style* or *Gnomon*: Then I let fall the Perpendicular F G upon the *Substyle* A G; so is a Triangle made, which if it be erected Perpendicularly upon the *Substyle* A G, the *Style* A F shall be Parallel to the *Axis* of the *World*, and cast a Shadow upon the Hour of the Day.

Having made this *Dyal*, you have made four several *Dyals*; whereof this is one; And his Opposite, *viz. North Declining Westwards* 30 Degrees *Inclining* to the *Horizon* 70 Degrees is another: The *South Declining Westwards* 30 Degrees *Reclining* from the *Zenith* 20 Degrees is another: And his Opposite, *viz. North Declining Eastwards* 30 Degrees inclining to the *Horizon* 70 Degrees is the other.

## PROB. XIII.

### *To make a* Dyal *upon a* Declining Inclining Plain.

THE Precepts for making these *Dyals* are delivered in the foregoing Problem: Therefore we shall at first come to an Example.

I would make a *Dyal* upon a *Plain* in *Londons Latitude*, *Declining* from the *South Westwards* 25 Degrees, and *Inclining* towards the *Horizon* by the space of an Arch containing 14 Degrees. Having first described on the *Plain* a Semi-Circle, as was directed, Prob. 4. I Rectifie the *Globe*, *Quadrant of Altitude*

*Altitude*, *Colure*, and *Hour-Index*, as by the ſame Probleme, and bring the lower end of the *Quadrant of Altitude* to the Degree of the *Plains Declination*, *viz.* to 25 Degrees counted from the *South Weſtwards*, and the ends of the *Gnomonical Semi-circle*, to the Degrees of *Azimuth*, between which the *Plain* lies, *viz.* to 25 Degrees from the *Weſt Northwards*, and 25 Degrees from the *Eaſt Southwards*; and the middle of the *Gnomonical Semi-circle* to the Degree of the *Plains Inclination*, *viz.* 14 Degrees counted from the *Zenith* downwards on the *Quadrant of Altitude*: Then counting the Degrees of the *Gnomonical Semi-Circle* contained between the middle of the ſame and the *Brazen Meridian*, I find 5 Degrees 30 Minutes; Therefore I number in the Semi-Circle deſcribed on the *Plain* from the Perpendicular *Weſtwards*, 5 Degrees 30 Minutes, *viz.* from B to C, and there place the 12 a Clock-line. For finding all the Fore-Noon Hour diſtances

| | | | | | |
|---|---|---|---|---|---|
| I turn the *Globe Eaſtwards* till the *Index* points to | 11 | a Clock, or till 15 Deg. of the *Equa.* paſs through the *Meridian* and find the Colure Cut the *Gnomon Semi-Circle* in | 20. 5 | counted from the middle of the *Gnomon Semi-circle.* |
| | 10 | | 36. 7 | |
| | 9 | | 56.24 | |
| | 8 | | 76.31 | |

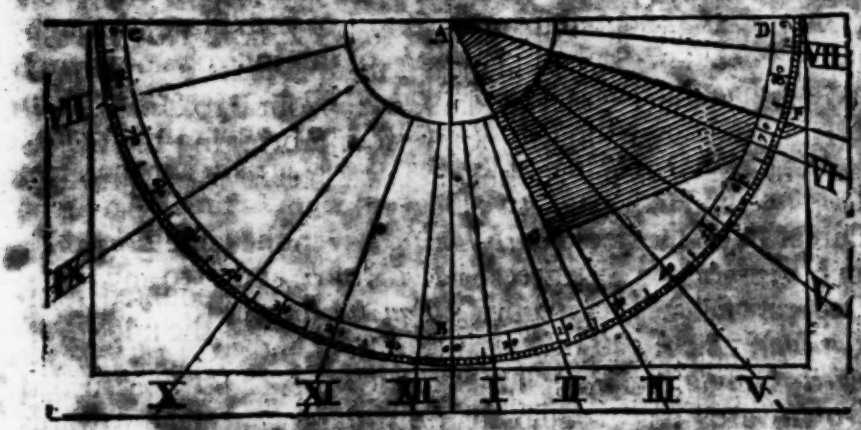
And theſe are the diſtances of all the Fore-Noon Hour Lines, to which ſeveral diſtances I made Pricks on the *Weſt* ſide the Semi-circle on the Plain, *viz.* from B to C.

The After-noon Hour Lines are found bringing the *Colure* again to the *Meridian* and the *Index* of the *Hour-circle* to 12. For then

| | | | | |
|---|---|---|---|---|
| turning the *Globe Weſtwards* till the *Index* points to | 1 | a Clock, or till 15 Degrees of the *Equator* paſs through the *Meridian*, I find the *Colure* Cut the *Gnomonical Semi-circle* in | 6.20 | counted from the middle of the *Gnomonical Semi-Circle.* |
| | 2 | | 18. 2 | |
| | 3 | | 28.45 | |
| | 4 | | 39.56 | |
| | 5 | | 52.30 | |
| | 6 | | 67.19 | |
| | 7 | | 84.63 | |

And theſe are the diſtances of the After-noon Hour Lines which I alſo Prick down at their reſpective diſtances from the Perpendicular *Eaſtwards*, *viz.* from B towards D on the *Plain*, and by drawing Lines from the Center A through all the Pricks, I have all the Hour Lines that this *Plain* will admit of.

Having drawn the Hour Lines, I remove the lower end of the *Quadrant of Altitude* to the Deg. of the *Horizon* opposite to the Degree it was at before, *viz.* to 25 Degrees from the *North Eastwards*, which is so much as the *Declination* is *Westward*; but I let the *Gnomonical Semi-Circle* stand as it did, and turn about the *Globe* till the *Colure* Cuts the *Quadrant of Altitude* in 24 Degrees counted from the *Horizon* upwards, which is the *Inclination* of the *Plain*: Then I find 24 Degrees 3 Minutes comprehended between the middle of the *Gnomonical Semi-Circle* and the *Brasen Meridian*, which is the distance of the *Substyle* from the Perpendicular; and this distance I count *Westwards* on the *Plain*, because the middle of the Semi-Circle lies *Westwards* on the *Globe*, and draw the Line AG through it for the *Substyle*: And I find the *Gnomonical Semi-Circle* Cut the *Colure* in 48 Degrees 5 Minutes for the Height that the *Style* must be Elevated over the *Substyle*. Therefore I make a Prick on the *Plain* 48 Degrees 5 Minutes distant from the *Substyle*, and through that Prick I draw the Line AF to represent the *Style* or *Gnomon*. Then I let fall the Perpendicular F G upon the *Substyle* A G, so is there a Triangle made; which if it be Erected




Perpendicularly upon the *Substyle* A G the *Style* A F shall be parallel to the *Axis* of the *World*, and cast a Shadow upon the Hour of the Day.

Having made this *Dyal* you have also four *Dyals* made; as well as in the former Probleme: For this is one, and it's opposite, *viz.*, *North Declining Eastwards* 25 Degrees, *Reclining* 76 Degrees is another; The *South Declining Eastwards* 25 Degrees.

*Incli-*

*Incliner* 14 Degrees is another, and its oppoſite, viz. *North Declining Weſtwards* 25 Degrees *Declining* 76 Degrees is another.

## PROB. XIV.

*To find in what Place of the* Earth, *any manner of* Plain *that in your* Habitation *is not* Horizontal, *ſhall be* Horizontal.

IT was ſaid in the *Preface* that all manner of *Plains* however Situate, are parellel to ſome Country or other on the *Earth*: Therefore all manner of *Plains* are indeed *Horizontal Plains* and the diſtances of the Hour Lines to be deſcribed on them may be found as the diſtances of the Hour Lines of the *Horizontal* Dyal in Prob. 3. It reſts now to learn in what Place of the *Earth* any *Plain* that is not *Horizontal* in your Habitation ſhall become *Horizontal*: And for help of your Underſtanding herein, Take theſe following Rules.

1. If your Plain be Erect Direct North, or South, it ſhall be an *Horizontal* in the ſame Longitude at 90 Degrees diſtance on the Meridian (counted from the *Zenith* of your Place) through the *Equinoctial*. See an *Example* of this in Prob. 4. where I have reduced an Erect Direct Dyal, to an *Horizontal*. Thus an *Erect Plain* under the *Pole* is an *Horizontal* under the *Equator*; and an Erect Direct in 80 Degrees *North Latitude* is in the ſame *Longitude* an *Horizontal* at 10 Degrees *South Latitude*. An Erect Direct in 70 Degrees *North Latitude*, is in the ſame *Longitude*, an *Horizontal* at 20 Degrees *South Latitude*: and ſo to any other Degrees of *Latitude* (as aforeſaid) till you come to 45 Degrees *Latitude*, where an *Erect* is an *Horizontal*, and an *Horizontal* an *Erect*: Only as the Hour Lines of the *Horizontal* being turned Downwards) are numbred from the Right Hand towards the Left in the Erect Direct Dyal they are numbred from the the Left Hand towards the Righ.

2. If your *Plaon* be Erect Declining, it ſhall be an *Horizontal Plain* at that point on the *Globe* which is againſt the Degree of Declination, found in the *Horizon*.

But note, If your *Plain* Declines Weſtwards, the *Sun* comes ſooner to the *Meridian* of it, than to the *Meridian* of the Place where

where it becomes an *Horizontal Plain*, and that by so many Hours or Minutes as the Degrees of the difference of *Longitude* between the two Places converted into *Time* amounts to. If it *Declines Eastward*, the *Sun* comes so much later to the Meridian of it. Add for this Cause (though the making this *Dyal* be the same with an *Horizontal Dyal* for another place, yet in Respect of *Time*) there will be a difference between them.

## *Example.*

I would make the *North Dyal Declining East* 63 Degrees, as in Prob 9. by the *Plain* of the *Horizon*: First I seek in what Place of the *Earth* it shall become an *Horizontal Plain*: Thus, I Elevate the *Pole* of the *Globe* 51 ½ Degrees above the *Horizon*, and bring the *Vernal Colure* to the *Meridian*, then I count from the *South* Point in the *Horizon Eastwards* 27 Degrees, and on the Point on the *Globe* directly against those 27 Degrees I make a Prick for the place where a *Plain* that *Declines* 63 Degrees from the *North Eastwards* at *London* shall be *Horizontal*; or which is all one, this *Declining Plain* at *London* shall ly in the *Horizon* of that Prick. This Prick for distinction sake we shall hereafter call the *Horizontal Place*. Then by Prob. 1 of the Second Book, I examine the *Latitude* and *Longitude* of this *Horizontal Place*, and find *Latitude* 33 40 *South*; and *Longitude* from the *Colure* 33 Degrees, which is the difference of *Longitude* between *London* and the *Horizontal Place*: which being converted into *Time*, by allowing for every 15. Degrees 1. Hour of *Time*, gives 2 Hours 12 Minutes that the *Sun* comes sooner to the *Meridian* of the *Horizontal Place*, than to the *Meridian* of the *Plain* at *London*; so that when it is 12 a Clock There, it will be but 9 a Clock 48. Minutes Here; when 12. a Clock Here, it will be 2. a Clock 12. Minutes There, &c.

Having thus found in what *Longitude* from *London* and *Latitude* this *Plain* is Parallel to the *Horizon*, I seek the distance of the Hour-lines upon the *Plain* of the *Horizon*. Thus, I Elevate the *Pole* of the *Globe* to the Height of the *Pole* in the *Horizontal Place*, viz. 33 Degrees 40 Minutes, and bring the *Horizontal Place* on the *Globe* to the *Meridian*, and the *Index* of the *Hour Circle* to 12. Then I examine the Degree of the *Horizon* the *Colure* Cuts, and find it 19 ¾ from the *South Westwards*, This 19 ¾ Degrees

Degrees repreſents the *Meridian* Line of the *Horizontal Place*: And alſo the *Subſtylar* Line here at *London*; Therefore this 19½ Degrees I count from the Perpendicular A B of the Plain, and from the Center A draw the Line A G through them; Becauſe from this Line on the *Plain* all the Hour Lines muſt be numbred, and not (as all along hitherto) from the Perpendicular of the *Plain*. Then

| | | | | |
|---|---|---|---|---|
| turning the *Globe Eaſtwards* till the *Index* points to | 11 a Clock; or till | 15 Deg. of the *Equator* paſs through the *Meridian*; I find the *Colure* Cut the *Horizon* in | 10. 2<br>0.45<br>6.12<br>15.25<br>26.11<br>40.30<br>60. 0 | counted from the *Meridian*. |
| | 10 | | | |
| | 9 | | | |
| | 8 | | | |
| | 7 | | | |
| | 6 | | | |
| | 5 | | | |

And theſe are the diſtances of the Foor-noon Hour Lines; which diſtances I transfer by Pricks to the *Plain*. But as in Prob. 9. I ſought the diſtances from the Perpendicular on the *Plain*, ſo now in this Caſe (as was ſaid before) I ſeek them from the *Subſtyle*, and through theſe Pricks I draw Lines from the Center, as in other *Dyals*, and theſe Lines ſhall be the Fore-Noon Hour Lines.

To find the After-noon Hour diſtances, I bring the *Horizontal Places* on the *Globe* again to the *Meridian*, and the *Index* of the *Hour-Circle* to 12, and

| | | | | |
|---|---|---|---|---|
| turning the *Globe Weſtwards* till the *Index* points to | 1 | 2 Clock, or till 15 Deg. of the *Equator* paſs through the *Meridian*, I find the *Colure* Cut the *Horizon in* | 31. 5<br>46.32<br>68. 5<br>95.37 | counted from the *Meridian* |
| | 2 | | | |
| | 3 | | | |
| | 4 | | | |

And theſe are diſtances of all the After-noon Hour Lines; which I alſo transfer to the *Plain*, counting them from the *Subſtyle*, and draw Lines from the Center A through the diſtances, and theſe Lines ſhall be the After-noon Hour Lines.

Then from the *Subſtyle* I count the Degrees and Minutes of the *Latitude* of the *Horizontal Place*, viz. 33 Degrees, and through theſe Degrees and Minutes I draw the Line AE from the Center A for the *Style*: Then from the *Style* I let fall the Perpendicular FG upon the *Subſtyle*, ſo is there a Triangle made which if it be erected perpendicularly upon the *Subſtile* A G, the *Style* AE ſhall be parellel to the *Axis* of the *World*, and caſt a ſhadow upon the Hour of the Day.

3. If

3. If your *Plain* be a *Direct Recliner* Seek in the *Longitude* of your Place the Complement to 90 of your *Plains Reclination*. For there a *direct Recliner* becomes an *Horizontal Plain*.

4. If your *Plain* be a *Declining Recliner*: The *Globe* and *Quadrant of Altitude* Rectified, Bring your Habitation on the *Terrestrial Globe* to the *Meridian*, and the *Quadrants Altitude* to the *Declination*, as by the Second Rule in this Probleme; and count upwards on the *Quadrant of Altitude* the *Reclination*, and there make a prick on the *Globe* by the side of the *Quadrant of Altitude*, for at that prick on the *Globe* the *Declining Reciner* shall become an *Horizontal Plain*; then examine the Latitude of that Prick, as by prob. 1. of the 2d. Book, and the difference of Longitude, as by prob. 9. of the 3d Book, and convert the difference of Longitude into *Time*, by allowing for every 15 Degrees 1 hours *Time*, for every Degree 4 Minutes *Time*, and so proportionably, so shall you know what Hours and Minutes the *Sun* comes sooner or later to the Meredian of your Habitation than to the Meridian of that *Place* where it becomes an *Horizontal Plain*; Sooner, if the *Globe* were turned *Eastwards*; but Later if it where turned *Westwards*.

Having thus found out where this *Plain* becomes *Horizontal*, make your *Dyal* to this *Plain*, as by the second Rule in this Probleme: Find also the *Style*, as is there directed.

5. If your *Plain* be a *Declining Incliner*, the *Globe* and *Quadrant of Altitude* Rectified, Bring the *Colure* to the *Meridian* and the *Quadrant of Altitude* to the Degree of the *Horizon*, opposite to the Degree of the *Plains Declination*, and count upwards on the *Quadrant of Altitude* the Degrees of *Inclination*, and make a Prick there; For in the *Antipodes* of that Prick (found as by Prob. 29 of the Second Book) that *Declining Incliner* shall become an *Horizontal Plain*. Then find the *Latitude* and difference of *Longitude* of this *Antipodes*, by the former Rule, and make a *Dyal* to that *Plain*, as by the second Rule in this Probleme. Find also the *Style*, as therein directed.

PROB.

## PROB. XV.

*To make a* Dyal *on the* Ceeling *of a* Room, *where the* Direct Beams *of the* Sun *never come.*

Find some convenient place in the *Transum* of a Window to place a small round piece of Looking-Glass about the bigness of a Groat, or less, so as it may lie exactly *Horizontal*: The point in the middle of this *Glass* we will mark A, and for distinctions sake (with Mr *Palmer*) call it *Nodus*. Through this *Nodus* you must draw a *Meridian* Line on the Floor, Thus: Hang a plumb-line in the Window exactly over *Nodus*, and the Shadow that the Plumb-line casts on the Floor just at Noon will be a *Meridian*-line; Or you may find a *Meridian*-line otherwise, as by the *Preface*. Having drawn the *Miridian*-line on the Floor, find a *Miridian*-line on the Ceeling, thus: Hold a plumb-line to the Ceeling, over that end of the *Meridian*-line next the Window; If the Plumbet Hang not exactly on the *Meridian*-line on the Floor remove your hand on the Ceeling one way or other, as you see cause till it do hang quietly just over it, and at the point where the Plumb-line touches the Ceeling make a mark, as at B, that mark B shall be directly over the *Meridian*-line on the Floor: then remove your Plumb-line to the other end of the Meridian-line on the Floor, and find a point on the Ceeling directly over it, as you did the former Point, as at C, and through these two point B and C on the Ceeling strain and striks a Line Blackt with Small-Coal or any other Colour (as *Carpenters* do) and that Line BC on the Ceeling shall be a *Merid.* line as well as that on the Floor: Then examine the *Altitude* of the *Equinoctial* as by prob. 6. of the Second Book you did the *Merid. Altitude* of the *Sun*, and fasten a String just on the *Nodus*, and remove that String in the *Meridian*-line on the Ceeling till it have the same Elevation in a *Quadrant*, that the *Equinoctial* hath in your Habitation, and through the point where the String touches the *Meridian*-line in the Ceeling shall a Line be drawn at right Angels with the *Merid.* to represent, the *Equinoctial* Line. Thus in our *Latitude* the Elevation of the *Equator* being 38½ Degrees; I remove the String fastned to the *Nodus* forwards or backwards in the *Meridian*-line of the Ceeling.

Ceeling, till the Plumb-line of a Quadrant when one of the ſides are applied to the String, falls upon 38½ Degrees, and then I find it touch the *Meridian* line at D in the Ceeling: therefore at D I make a mark, and through this mark ſtrike the Line DE (as before I did the *Merid.* Line) to Cut the *Meridiam*-line at Right Angles: This Line ſhall be the *Equinoctial*-Line.

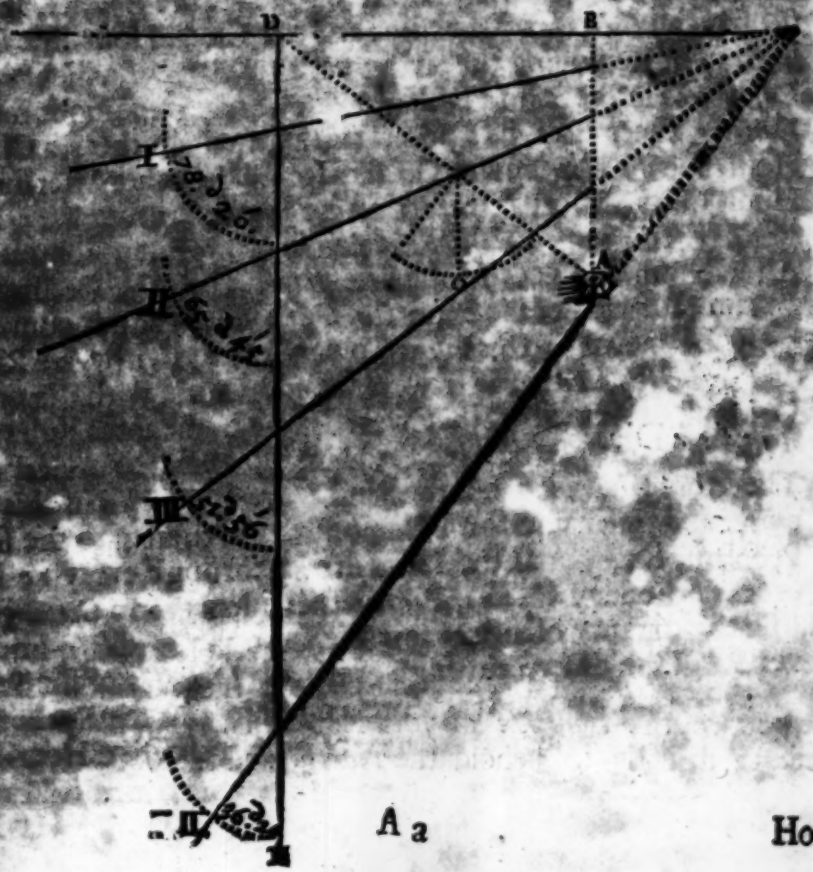
Then I place the Center of the *Semi-Circle of poſition* upon *Nodus*, and under-prop it ſo, that the Flat ſide of it may ly Parellel to the String when it is ſtrained between the *Nodus* and the *Equinoctial*, and alſo ſo as the String may ly on the diviſion of the *Semi-Circle of poſition* marked 0, when it is held up to the *Meridian*-line in the Ceeling. Then removing the String the ſpace of 15 Deg. in the *Circle of Poſition* to the *Eaſtwards*, and extending it to the *Equa.* on the Ceeling, where the String touches the *Equa.* there ſhall be a point thro' which the 1 a Clock Hour-line ſhall be drawn: and Removing the String yet 15 Deg. further to the *Eaſtwards* in the *Semi-Circle Poſition*, and extending it alſo to the *Equator*, where it touches the *Equator*, there ſhall be a Point through which the 2 a Clock Hour-line ſhall be drawn. Removing the String yet 15 Degrees further to the *Eaſtwards* in the Semi-*Circle of Poſition*, and extending it to the *Equator*, there ſhall be a point through which the 3 a Clock Hour-line ſhall be drawn. The like for all the other After-noon Hour Lines; ſo oft as the String is removed through 15 Degrees on the Semi-*Circle of Poſition*, ſo oft ſhall it point out the After-Noon diſtances in the *Meridian*-line on the Ceeling.

The Situation of the Semi-*Circle of poſition* cannot conveniently be ſhewn in this Figure, unleſs it be drawn by the Rules of *Perſpective*; niether if it were, would it ſuit with the other Demonſtrations, except they were drawn by the ſame Rules alſo which to do would be hard for young Learners to underſtand: Therefore I have left out the Semi-*Circle of Poſition* in this *Figure*, and refer you for a Demonſtration thereof to the ſixth Problem; for even as the Lines drawn through every 15 Degrees of the Semi-*Circle of Poſition* there denote in a *Contingent*-line the diſtance of any Hour-line from the *Meridian*-line, even ſo a Line drawn through every 14 Degrees of the Semi-*Circle of Poſition* poſited (as aforeſaid) point out the *Equinoctial* line on the Ceeling the diſtance of each reſpective Hour-line from the *Meridian*-line.

Having

Having thus found out the Points in the *Equator*, through which, the Afternoon Hour-lines are to be drawn, I may find the Forenoon Hour-diſtances alſo the ſame way, *viz.* by bringing the String to the ſeveral 15 Degrees on the Weſt Side the Semi-circle of *Poſition*, or elſe I need only meaſure the diſtances of each Hour-diſtance found in the *Equator* from the *Meridian*-line on the Ceiling; for the ſame number of Hours from 12, have the ſame diſtance in the Equinoctial-line on the other ſide the *Meridian*, both before and after Noon: The 11 a Clock Hour-diſtance is the ſame from the *Meridian*-line, with the 1 a Clock diſtance on the other ſide the *Merid.* the 10 a Clock diſtance, the ſame with the 2 a Clock diſtance, the 9 with the 3, *&c.* And thus the diſtances of all the Hour-lines are found out on the *Equator*.

Now, if the Center of this Dial lay within Doors, you might draw Lines from the Center, thro' theſe Pricks, in the *Equator*, and thoſe Lines ſhould be the Hour-lines, as in other Dials: But the Center of this Dial lies without doors in the Air, and therefore not convenient for this purpoſe: So that for drawing the



Hour-lines, you must consider what Angle every Hour-line, in an *Horizontal Dial*, makes with the *Meridian*; that is, at what distance, in Degrees and Minutes, the Hour-lines of an *Horizontal Dial* cut the *Meridian*, which you may examine, as by *Prob.* 3. for an Angle, equal to the Complement of the same Angle, must each respective Hour-line with the *Equator* on the Ceiling have.

Thus upon the Point, mark'd for each Hour-distance in the *Equinoctial Line* on the Ceiling, I describe the Arches I, II, III, IV, as in the Figure, and finding the distance from the *Meridian* of the Hour-lines of an *Horizontal Dial*, to be according to the third Problem: Thus

The { 1 / 2 / 3 / 4 } a Clock Hour-line { 11.40 / 24.15 / 38.14 / 53.36 } whose Complement to 90, is { 78.20 / 65.45 / 51.56 / 36.24 }

I measure in a *Quadrant* of the same *Radius* with those Arches, already drawn from the *Equinoctial* Line,

for the { 1 / 2 / 3 / 4 } a Clock Hour { 78.20 / 65.45 / 51.56 / 36.24 }

and transfer these distances to the Arches drawn on the Ceiling: For then Straight-Lines, drawn through the mark, in the Arch, and through the mark, in the *Equator*, and prolonged both ways, to a convenient Length, shall be the several Hour-lines (aforesaid.) And when the *Sun* shines upon the Glass at *Nodus*, its Beams shall reflect upon the Hour of the Day.

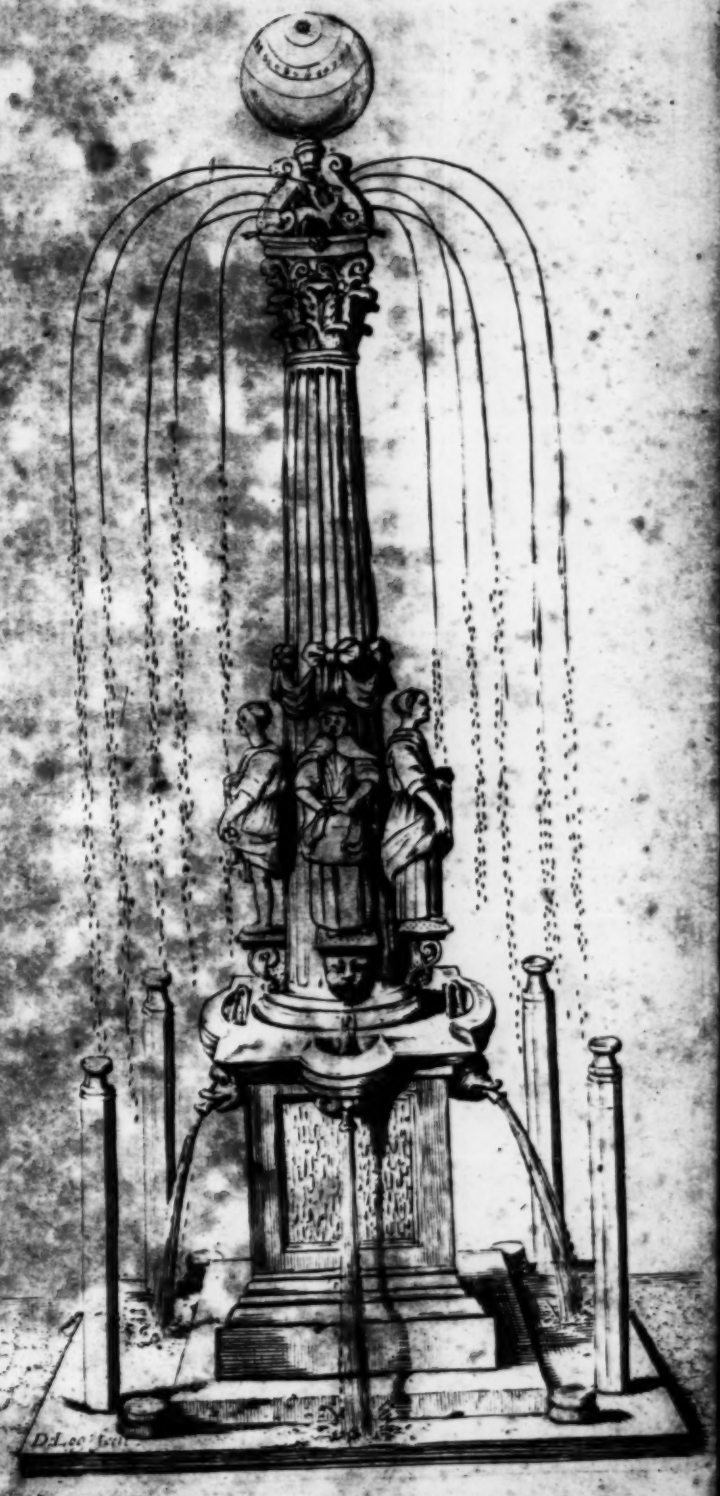
## PROB. XVI.

*To make a* Dial *upon a solid* Ball *or* Globe, *that shall shew the Hour of the Day, without a* Gnomon.

THE *Equinoctial* of this *Globe*, or (which is all one) the middle Line, must be divided into 24 equal Parts, and marked with 1,2,3,4, *&c.* to 12. and then beginning again with 1,2,3, *&c.* to 12. Then if you Elevate one of the Poles so many Deg. above an Horizontal Line, as the Pole of the World is Elevated above the *Horizon* in your Habitation, and place one of the 12 directly to behold the *North*, and the other to behold the

the *South*; when the *Sun* ſhines on it, the *Globe* will be divided into two Halfs; the one Enlightned with the *Sun-ſhine*, and the other ſhadowed: And where the Enlightned Half is parted from the Shadowed Half, there you ſhall find in the *Equinoctial* the Hour of the Day; and that on two places on the Ball, becauſe the *Equinoctial* is cut in two oppoſite Points by the Light of the *Sun*.

A Dial of this ſort was made by Mr. *John Leek*, and ſet up on a Compoſite Column at *Leaden-Hall* Corner in *London*, in the Majoralty of Sir *John Dethick*, Knight. The *Figure* whereof I have inſerted, becauſe it a pretty piece of Ingenuity, and may perhaps, ſtand ſome Lover of Art in ſtead, either for Imitation, or Help of Invention.



## PROB. XVII.

*To make a* Dial *upon a* Glass Globe, *whose* Axis *shall cast a Shadow upon the Hour of the Day.*

FIrst, divide the Equinoctial of your *Globe* into 14 equal Parts; and having a Semi-circle cut out of some Brass Plate, or thin Wood, to the same Diameter your *Globe* is of, or a very little wider: Apply this Semi-circle to the *Globe*, so as the upper edge of each end of the Semi-circle may touch the Poles of the *Globe*, and the middle of the Semi-circle may at the same edge cut through some division made in the Equinoctial: For then a Line drawn by the Edge of the Semi-circle, thus posited, shall be a *Meridian*-line. The same way you must draw *Meridian* lines thro' every division of the Equinoctial, and set Figures to them, beginning with 1, 2, 3, 4, &c. to 12, and then beginning again with 1, 2, 3, 4, &c. to 12 again. This *Globe* being made of Glass, and having an *Axis* of Wyre passing thro' it from Pole to Pole, will be an *Horizontal Dial* all the World over, if its *Axis* be set parallel to the *Axis* of the World in the same place, and one of the *Meridian*, marked 12, be set so, as it may directly behold the North point in Heaven, and the other the *South* point in Heaven, for then the *Axis* of the Globe shall cast a Shadow upon the Hour of the Day.

And if you divide the upper Half of the *Glass Globe* from the under half, when the *Axis* stands parallel to the *Axis* of the World, by a Circle drawn round about the *Globe*, that Circle shall represent the *Horizon*, and the *Meridian*-lines, drawn on the *Globe*, shall be the Hour-lines, and have in the Horizontal Circle the same distance from the 12 a Clock Line, that the same Respective Hour-line was found to have, as by *Prob.* 3. of this Book.

But because the Shadow of this *Axis* will not be discerned thro' the Glass Body, therefore you may with Water and White Lead ground together, lay a Ground on the Inside of the under Half of the Glass to the Horizontal Circle, (as Looking-Glass-makers do their Looking-Glasses with *Tinfoil*) for then the Shadow will appear.

Such a Glass Globe-Dial had *Robert Titchborn*, once Lord-Mayor of *London*, standing in his Garden, supported by *Atlas*.

*The End of the Fifth Book.* The

# The Sixth BOOK.

## Shewing the Practical Uſe of the

# GLOBES.

## Applying them to the Solution of SPHERICAL TRIANGLES.

## PRÆFACE.

THE *Solution of* Spherical Triangles, *is to know the Length of their* Sides, *and Width of their* Angles. *Theſe have already by many Learned Men been Taught to be perform'd by a* Canon *of* Sines *and* Tangents; *and alſo by many* Inſtruments, *ſome ſerving as Tables of* Sines *and* Tangents; *ſuch as are the* Sectors, Scales, *the* Spiral Line, *&c. And others ſerving to repreſent the* Globe: *Such as be the* Mathematical Jewel, Aſtrolabium Catholicum, *and ſeveral other Projections of the* Sphere. *But none hath as yet Taught the Solution of* Spherical Triangles *by the* Globe *it ſelf; tho' it be the moſt Natural, and moſt Demonſtrative Way of all, and indeed, ought firſt to be learnt before the Learner enters upon any other Way.*

*To this, Authors of* Trigonometry *agree; for the moſt of them, in their Books, give Caution, that the Learner be already*

*already ſufficiently grounded in the Principles of the* Globe: *For thoſe* Lines *or* Circles, *which either in* Tables *or other* Inſtruments *you force your Imagination to conceive, repreſent your* Line *or* Circle *in Queſtion*; *thoſe* Lines *and* Circles (*I ſay*) *you have Actually and Naturally deſcribed on the* Globe, *and therefore may at a Single* Operation, *or perhaps only by a ſudden* Inſpection, *have an* Anſwer *annexed, according as the Nature of your* Queſtion *ſhall require*; *and that more Copiouſly, than by* Tables *of* Sines *and* Tangents: *For therein you find but one* Queſtion *at once Reſolved*; *but by the* Globe, *you have always two Reſolved together.*

## *Of the* Parts *and* Kinds *of* Spherical Triangles.

### *THEOREMS.*

1. ALL *Spherical Triangles* are made of ſix Parts; three Sides, and three Angles. The Sides are joined together at the Angles, and meaſured by Degrees of a Great Circle from one end to the other. The Angles are the diſtance of the two joined Sides: And they are alſo meaſured by an Arch of a Circle, deſcribed on the *Angular Point*. If any three of theſe Parts be known, the reſt may be found.

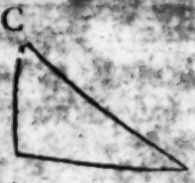
2. All *Spherical Triangles* are either Right Angled, or Oblique Angled. A Right Angle contains 90 Degrees; an Oblique Angle either more, or leſs.

3. If a *Spherical Triangle* have one or more Right Angles, it is called a *Right Angled Spherical Triangle*: But if it have no Right Angle, it is called an *Oblique Angled Spherical Triangle*.

4. If an *Oblique Spherical Triangle* have one Angle greater than a Right Angle, it is called an *Obtuſe Angled Spherical Triangle*: But if it have no Angle greater, it is called an *Acute Angled Spherical Triangle*.

5. In *Right Angled Triangles*, the Sides including the Right Angle, are called Legs: And the Side oppoſite to the Right Angle

gle is called *Hypothenusa*. Thus the Sides A B and A C, in the following Triangle, are called Legs; and the Sides B C, is called *Hypothenusa*.




6. In a *Right Angled Spherical Triangle* one of the Legs are called Base; the other Perpendicular: Thus the Leg A B is Base, and the Leg C A Perpendicular. But the Terms may be varied; for the Base may be made Perpendicular, and the Perpendicular Base. Also one of the Adjacent Angles is called the *Angle at the Base*; the other the *Angle at the Perpendicular*: Thus the Angle B is called the *Angle at the Base*: The Angle C the *Angle at the Perpendicular*.

## PROB. II.

*The Legs of a Right Angled Spherical Triangle given, to find the* Hypothenusa, *and the two other Angles.*

THE Base of a Right Angled Spherical Triangle shall in this following Treatise be always placed on a *Meridian*, the *Perpendicular* on the *Equator*, the *Hypothenusa* on the *Quadrant of Altitude*, and the Angle at the Base shall be measured in an Arch of the *Horizon*.

Elevate the Equinoctial into the *Zenith*, so shall the Poles of the Globe lye in the *North* and *South* Points of the *Horizon*.

Then count from the Equinoctial on the *Meridian*, if you use the *Terrestrial Globe*; or on the *Vernal Colure*, if you use the *Celestial*, because they are divided from the Equinoctial, either way, into 90 Degr. and because from thence the Degr. of the Equinoctial are begun to be numbred: Count (I say) from the Equinoctial the number of Degr. the Base contains, and there make a Prick: Then count in the Equinoctial from the first Meridian, the number of Degr. the Perpendicular contains, and make there a Second Prick: Bring that Second Prick to the *Brazen Meridian*, so shall the first *Meridian* be separated from the *Brazen Meridian* by the quantity of an Arch, equal to the measure of the *Perpendicular*: Then having the *Quadrant of Altitude* screwed in the *Zenith*, turn it about till the Side of it cut the Prick made in the first Meridian; so shall the

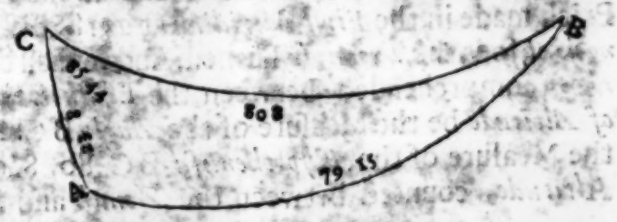
Triangle

*Triangle* be represented on the *Globe*. The *Base* shall lie on the *First Meridian* between the *Equinoctial* and the *Quadrant of Altitude*, the *Perpendicular* in the *Equinoctial* between the *First Meridian* and the *Brazen Meridian*, and the *Hypothenusa* on the *Quadrant of Altitude* between the *Zenith* and the *First Meridian*, and the number of Degrees between each of these respective *Arches* shall be the Measure of each respective *Side*. For the *Angles*; The *Right Angle* is known to be 90 Degrees, by the Second *Theorem* in the *Preface*. The Measure of the *Angle* at *Perpendicular* is numbred between the *East* Point in the *Horiz.* and the Graduated edge of the *Quadrant of Altitude*: But to find the *Angle* at the *Base* you must turn the *Triangle*, making the *Perpendicular Base*, and the *Base Perpendicular*.

*Example.*

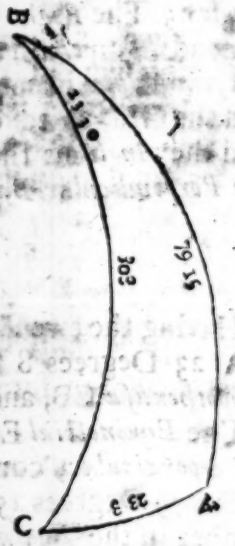
Having the two *Legs* given AB 79 Degrees 15 Minutes, and CA 23 Degrees 8 Minutes, I would find the Measure of the *Hypothenusa* CB, and the *Angles* B, C.

The *Equinoctial* Elevated as before, I make AB *Base*, and C A *Perpendicular*, counting in the *First Meridian* from the *Equinoctial* 79 Degrees 15 Minutes, and there I make a Prick: Then I number in the *Equinoctial* from the *First Meridian* 23 Degrees 8 Minutes the Length of the *Perpendicular*, and there I make a Second *Prick*: This Prick I bring to the *Brazen Meridian*, so is th: *First Meridian* separated from the *Brazen Meridian* so many Degrees and Minutes as is the Length of the




*Perpendicular* CA: Then I screw the *Quadrant of Altitude* to the *Zenith*, *viz.* directly over the *Equinoctial*, and move it about till the Edge of it touch the Prick made in the *First Meridian*: So is the *Triangle* made on the *Globe*: And the number of Degrees and Minutes of the *Quadrant of Altitude* comprehended between the *First Meridian* and the *Zenith* is the Measure of the *Hypothenusa* CB; which in this *Example* is 80 Degrees 8 Minutes: The number of Degrees in the *Horizon* compre-

hended between the *Equinoctial* and the *Quadrant of Altitude* is the Measure of the *Angle* C, 85 Degrees, 44 Minutes: the *Angle* A is a *Right Angle*, 90 Degrees: And to find the *Angle* B Turn the *Triangle* (all but the Letters): Thus as before A C was *Base*, so now I make B A *Base*, and as before A B was *Perpendicular*, so now C A shall be *Perpendicular*: so is your *Triangle* Turned.




Now, as before I counted 79 Degrees 15 Minutes from the *Equinoctial* on the *First Meridian*, which was the Length of that *Base*, so now I count 23 Degrees 8 Minutes on the *First Meridian*, which is the Length of this *Base*, and there (as before) I make a Prick; and as before I counted 23 Degrees 8 Minutes on the *Equinoctial* from the *First Meridian*, which was the Length of that *Perpendicular*; so now I count 79 Degrees 15 Min. on the *Equinoctial*, which is the Length of this *Perpendicular*; and there I make a Prick on the *Equinoctial*: Then I bring this Prick (as before to the *Brazen Meridian*, so shall the *First Meridian* be distant (as before) from the *Brazen Meridian* so many Deg. and Min. as is the Length of this *Perpendicular*, *viz.* 79. 15. Then having the *Quadrant of Altitude* screwed to the *Zenith*, I turn it about till the Edge of it touch the Prick made in the *First Meridian* at 23. 8. distant from the *Equinoctial*; so is the *Triangle* Turned: And so shall the Arch of the *Horizon* comprehended between the *Equinoctial* and the *Quadrant of Altitude* be the Measure of the *Angle* B C. 23. 30. you also see the Measure of the *Hypothenusa* B C 80. 8 on the *Quadrant of Altitude*, counted between the *Zenith* and the *First Meridian*.

## PROB. II.

A Leg *and the* Hypothenusa *given, to find the Rest.*

*Example.* The *Leg* given shall be C A in the former *Triangle* 23 Degrees 8 Minutes. The *Hypothenusa* C B 80 Degrees 8 Minutes. The *Equinoctial* and *Quadrant of Altitude* Rectified, as by the last Probleme, Number the *Leg* C A 23 Degrees

Degrees 8 Minutes on the *Equinoctial* from the *First Meridian*, and there make a Prick; Bring this Prick to the *Brazen Meridian*, Then number on the *Quadrant of Altitude* the *Hypothenuſa* B C 80 Degrees 8 Minutes from the *Zenith* towards the *Horizon*, and make there on the Edge of the *Quadrant of Altitude* another Prick: Then turn the *Quadrant of Altitude* about till the Prick made on the Edge of it touch the *First Meridian*, ſo ſhall the *Triangle* be made: The *Arch* of the *Equinoctial* comprehended between the *First Meridian* and the *Brazen Merid.* ſhall repreſent A C the *Perpendicular*; the *Arch* of the *Quadrant of Altitude* comprehended between the *Zenith* and the *First Meridian* ſhall repreſent B C the *Hypothenuſa*; and the *Arch* of the *First Meridian*, comprehended between the *Equinoctial* and the *Quadrant of Altitude* ſhall repreſent B A the *Baſe*, which was one *Leg* ſought, and is (as you will find) 79 Degrees 15 Minutes. The *Angle* C you will find in the *Horizon* 85 Degrees 44 Minutes: The *Angle* A is the *Right Angle* 90 Degrees: And to find the *Angle* B you muſt Turn the *Triangle*, as you were directed in the former Probleme.

## PROB. III.

*The* Hypothenuſa *and an* Angle *given*, *to find the Reſt.*

THe *Hypothenuſa* given ſhall be B C of the *Triangle* in Prob. I. 80 Degrees 8 Minutes. The *Angle* given ſhall be C 85 Degrees 44 Minutes: The *Globe* and *Quadrant of Altitude* Rectified as by Prob. I. count the given *Angle* 85 Degrees 44 Minutes on the *Horizon* from the *Equinoctial*, and there place the *Quadrant of Altitude*: Then turn about the *Globe* till the *First Meridian* touch 80 Degrees 8 Minutes of the *Quadrant of Altitude* counted from the *Zenith* downwards, ſo ſhall the *Triangle* be made on the *Globe*: The *Arch* of the *Equator* comprehended between the *First Meridian* and the *Brazen Meridian* ſhall ſhew the Length of the *Perpendicular* C A 23 Degrees 8 Minutes; the *Arch* of the *First Meridian* comprehended between the *Equinoctial* and the *Quadrant of Altitude* ſhall ſhew the Length of the *Baſe* A B 79 Degrees 15 Minutes, the *Right Angle* made at the Interſection of the *Brazen Meridian* and the *Equinoctial* is 90 Degrees: and to find the Meaſure of the *Angle* B you muſt Turn the *Triangle*, as you were directed Prob. 1.

## PROB. IV.

*A* Leg *and* Angle *adjoyning given, to find the Rest.*

IN the *Triangle* of Prob. 1. the *Leg* given shall be CA 23 Degrees 8 Minutes, the *Angle* adjoyning shall be C, 85 Deg. 44 Minutes: The *Globe* and *Quadrant of Altitude* Rectified, as by Prob. 1. I turn about the *Globe* till the *First Meridian* be distant from the *Brazen Meridian* 23 Degrees 8 Minutes, the Length of the *Leg* CA: Then I count in the *Horizon* from the *Equinoctial* 85 Deg. 44 Minutes, the Measure of the *Angle* C; so is the *Triangle* made on the *Globe*. The *Arch* of the *First Meridian* comprehended between the *Quadrant of Altitude* and the *Equinoctial* shall shew the Length of the *Base* AB 79 Degrees 15 Minutes; The *Arch* of the *Quadrant of Altitude* comprehended between the *Zenith* and the *First Meridian* shall shew the Length of the *Hypothenusa* CB 80 Degrees 8 Minutes; The *Right Angle* made at the Intersection of the *Equinoctial* and the *Brazen Meridian* is 90 Degrees: And to find the Measure of the *Angle* B, you must Turn the *Triangle*, as you were directed Prob. 1.

## PROB. V.

*A* Leg *and the* Angle *opposite given, to find the Rest.*

IN the *Triangle* of Prob. 1. the *Leg* given shall be AB 79 Degrees 15 Minutes, the *Angle* opposite shall be C 85 Degrees 44 Minutes. The *Globe* and *Quadrant of Altitude* Rectified, as by Prob 1. I bring the *Quadrant of Altitude* to 85 Degrees 15 Minutes of the *Horizon*, the Measure of the *Angle* C: Then I Turn the *Globe* till 97 Degrees 15 Minutes of the *First Meridian* (which is the Measure of the *Leg* AB) touch the *Quadrant of Altitude*, so is the *Triangle* made on the *Globe*. The *Arch* of the *Equinoctial* comprehended between the *First Meridian* and the *Brazen Meridian* shews the Length of the *Leg* C A 23 Degrees 8 Minutes; the *Arch* of the *Quadrant of Altitude* comprehended between the *Zenith* and the *First Meridian*, shall shew the Length of the *Hypothenusa* CB 80 Deg. 8 Minutes: The *Right Angle* made at the Intersection of the *Equinoctial* and the *Brazen Meridian* is 90 Degrees: And to find the Measure of the *Angle* B, you must Turn the *Triangle*, as you were directed in Prob. 1.

PROB.

## PROB. VI.
### *The* Angles *given to find the* Sides.

IN this *Case* you muſt Turn the *Angles* into *Sides*, making an *Oblique Triangle* on the *Globe*, whoſe *Sides* ſhall be equal to the given *Angles*: ſo ſhall the *Angles* of this *Triangle* found, be the Meaſure of the *Sides* required.

*Example.*

In the *Triangle* of Prob. 1. The *Angle* A is 90 Degrees, the *Angle* B 23 Degrees 30 Minutes, the *Angle* C 85 Degrees 44 Minutes: The *Globe* and *Quadrant of Altitude* Rectified as by Prob. 1. I ſet the *Right Angle* A 90 Degrees on the *Brazen Meridian* between the *Pole* and the *Equinoctial*; For the *Angle* B, I number downwards on the *Quadrant of Altitude* 23 Degrees 30 Minutes, which ſhall be the *Side* repreſenting that Angle: for the *Angle* C I number on the *Firſt Meridian* from the *Pole* towards the *Equinoctial* 85 Degrees 44 Minutes, which ſhall be the *Side* repreſenting that *Angle*: Then I turn the *Globe* and *Quadrant of Altitude* till I can join the 23 Degrees 30 Minutes (counted before on the *Quadrant of Altitude*) and this 85 Deg. 44 Minutes (counted in the *Firſt Meridian*) together; So is a *Triangle* made on the *Globe*; whoſe *Sides* being equal to the *Angles* given, ſhall have its *Angles* equal to the *Sides Required*: Thus the *Arch* of the *Equinoctial* contained between the *Firſt Meridian* and the *Brazen Merid.* ſhall be found 23. 8. the Meaſure of the *Side* AC: the *Arch* of the *Horizon* between the neareſt *Pole* and the *Quadrant of Altitude* ſhall be found 79. 15. the Meaſure of the *Side* BA: And to find the *Hypothenuſa* BC, you have now *Data*'s enough; either to find it as by ſome of the former Problems; or elſe you may find it by Turning the *Triangle*; as by Prob. 1.

Theſe *Caſes* of *Right Angled Spherical Triangles* may be Wrought otherwayes by the *Globe*, if you alter its Poſition, making the *North* or *South* Points of the *Horizon Zenith*; or elſe the *Poles* of the *World*, or the *Poles* of the *Ecliptick*; and uſe the *Circle of Poſition* inſtead of the *Firſt Meridian* or Circles of *Longitude*. But theſe Inſtructions, together with a little Practice are (I judge) ſufficient: Therefore I ſhall refer Varieties to the Studies of the Induſtrious Student.

Of

# Of Oblique Triangles.

## PROB. VII.

*The three* Sides *given, to find the* Angles.

ELevate the *Pole* of the *Globe* above the *Horizon* to the complement of one of the given *Sides*, and screw the *Quadrant of Altitude* in the *Zenith*, so shall that given *Side* be comprehended between the *Pole* and the *Quadrant of Altitude*; Then count from the *Pole* upon the *First Meridian* the Measure of the Second *Side*, and there make a Prick: Count also from the *Zenith* upon the *Quadrant of Altitude* downwards the Measure of the Third *Side*, and make there on the Edge of the *Quadrant of Altitude* another Prick; Then turn the *Globe* and *Quadrant of Altitude* till you can joyn these two Pricks together, so shall your *Triangle* be made on the *Globe*: And then the number of Degrees of the *Equinoctial* comprehended between the *First Meridian* and the *Brazen Meridian* shall be the Measure of the *Angle* at the *Pole*: The *Arch* of the *Horizon* contained between the *Quadrant of Altitude* and the intersection of the *Brazen Merid.* with the *Horizon* on the side the *Pole* is Elevated, shall be the Measure of the Second *Angle*. For finding the Third, Turn the *Triangle*, as by Prob. I.

*Example.*

In the *Triangle* A B C annexed, the *Side* A B contains 38 Degrees 30 Minutes, the *Side* B C 25 Degrees, and the *Side* A C 60 Degrees: I would Measure these Angles; I place one of these *Sides* upon the *Merid. viz.* A B 38. 30. The Complement of 38.30. is 51 De. 30 M. Therefore I Elevate the *Pole* 51.30. above the *Horiz.* so shall the *Zenith* be distant from the Pole 38. 30. here I screw the *Quad. of Altitude* in the *Zenith* and count downwards on it the Measure of the *Side* B C 25 Deg. and there I make a Prick: then from the *Pole*

I count on the *Firſt Meridian* 60 Deg. the Meaſure of the *Side* AC, and there I make another Prick: Then I turn the *Globe* and *Quad. of Altitude* backwards or forwards till theſe two Pricks are joyned together; ſo ſhall the *Triangle* A B C be made on the *Globe*: The *Arch* of the *Brazen Meridian* comprehended between the *Pole* and *Zenith* ſhall repreſent the *Side* A B; the *Arch* of the *Quadrant of Altitude* comprehended between the *Firſt Meridian* and the *Brazen Meridian* ſhall repreſent the *Side* B C; and the *Arch* of the *Firſt Merid.* comprehended between the *Pole* and the *Quadrant of Altitude* ſhall repreſent the *Side* A C; The *Pole* ſhall repreſent the *Angle* A, the *Zenith* the *Angle* B, and the interſection of the *Firſt Meridian* with the *Quadrant of* Altitude ſhall repreſent the *Angle* C. The *Angle* at the *Pole* is Meaſured in the *Equator*; for the Degrees comprehended between the *Firſt Meridian* and the *Brazen Meridian* being 17 Degrees 15 Min. ſhews 17 Degrees 15 Minutes to be Meaſure of the *Angle* A: The *Angle* at the *Zenith* is Meaſured in the *Horizon*, for the Degrees comprehended between the Interſection of the *Brazen Meridian* with the *Horizon* on that *Side* the *Pole* is *Elevated* being 142 Degrees 42 Minutes, ſhews that 142 Degrees 42 Minutes is the Meaſure of the *Angle* B, Thus two *Angles* are found; the Third is wanting: which I find thus,

I Turn the *Triangle*, placing either A or C in the *Zenith*. *Example*. I place A at the *Zenith*, which before was at the *Pole*; ſo ſhall C be at the *Pole* and B at the Interſection of the *Firſt Merid.* and the *Quadrant of Altitude*, and the *Side* A C ſhall be comprehended between the *Pole* and *Zenith*: The *Side* AC contains 60 Degrees; its Complement to 90 is 30 Degrees: therefore I Elevate the *Pole* of the *Globe* 30 Degrees above the *Horizon*; ſo ſhall 60 Degrees be in the *Zenith*; therefore to 60 Degrees I ſcrew the *Quadrant of Altitude* and count on it downwards the meaſure of the other *Side* next the *Zenith*, *viz.* 38 Degrees 30 Minutes; and there I make a Prick: Then from the *Pole* on the *Firſt Meridian* I count the Meaſure of the Laſt *Side*, *viz.* 25 Degrees, and there I make another Prick: Then I turn the *Globe* and *Quadrant of Altitude* (as before) till theſe two Pricks joyn; ſo is the *Triangle* Altered on the *Globe*: For the *Arch* of the *Brazen Meridian* comprehended between the *Pole* and *Zenith* which before was 38 Degrees 30 Minutes is now 60 Degrees; the *Arch* of the *Quadrant of Altitude* comprehended between

tween the *First Meridian* and the *Brazen Meridian*, which before was 25 Degrees, is now 38 Degrees 30 Minutes, and the *Arch* of the *First Meridian* comprehended between the *Quadrant of Altitude* and the *Pole*, which before was 60 Degrees is now 25 Degrees. Thus the *Angle* C being now at the *Pole*, its Measure is found in the *Equinoctial*, *viz.* the *Arch* comprehended between the *First Meridian* and the *Brazen Meridian* which is 25 Deg. 24 Minutes, and the Measure of the *Angle* A, which is now in the *Zenith*: having its *Sides* the one an Arch of the *Brazen Meridian* the other an *Azimuth* (or which is all one) an *Arch* of the *Quadrant of Altitude*, is Measured in the *Horizon*, as all *Azimuths* are, and found 17 Degrees 15 Minutes, as before.

## PROB. VIII.

*Two* Sides *and the* Angle *contained between them given to find the Rest.*

EXample, in the former *Triangle* I have given the *Sides* A B, 38 Deg. 30 Min. AC, 60 Deg. and the *Angle* A 17 Deg. 15 Min. I Elevate the *Pole* of the *Globe* to the Complement of one of the given *Sides*; suppose the *Side* A B, which being 38 Deg. 30 Minutes Complement to 90 Deg. is 51 Deg. 30 Min. so shall the *Zenith* be distant from the *Pole* 38 Deg. 30 Min. the Measure of the *Side* A B: The other *Side* is 60 Deg. this 60 Deg. I count from the *Pole* in the *First Meridian*, and there I make a Prick: The *Angle* given is 17 Deg. 15 Min. this I count in the *Equinoctial* from the *First Meridian*, and this Degree and Minute in the *Equinoctial* I bring to the *Brazen Meridian*, so shall the *First Meridian* be separated from the *Brazen Meridian* 17 Deg. 15 Min. Then I screw the *Quadrant of Altitude* to the *Zenith*, and bring the *Side* of it to the Prick made in the *First Meridian*: so shall the *Triangle* be made on the *Globe*. Then to find the unknown *Side* BC, I count the number of Deg. on the *Quadrant of Altitude* contained between the *Zenith* and the *First Meridian*, and find 25 which is the Measure of the *Side* BC: To find the Measure of the *Angle* B, I count the number of Degrees contained between the intersection of the *Merid.* with the *Horizon* on that side the *Pole* is Elevated and the *Quadrant of Altitude*, and find 142 Deg. 42 Min. which is the Measure of the *Angle* B: And to find the *Angle* C, I turn the *Triangle*, as in Prob. 7.

PROB.

## PROB. IX.

*Two Sides and an Angle oppoſite to one of them given, to find the Reſt.*

*Example.* In the *Triangle* in *Prob.* 7. the Sides given are A B 38 *Degrees* 30 *Minutes*, and A C 60 *Degrees:* The *Angle* given, oppoſite to A C is B 142 *Degrees* 42 *Minutes:* I elevate the Pole to the Complement of one of the given *Sides*; ſuppoſe A B, which being 38 *Degrees* 30 *Minutes*, its Complement to 90 *Degrees* is 51 *Degrees* 30 *Minutes*; ſo is the Zenith diſtant from the Pole 38 *Degrees* 30 *Minutes.* To this 38 *Deg.* 30 *Minutes* I ſcrew the *Quadrant of Altitude*, and count in the Horizon from the Interſection of the Meridian with the Horizon, on that ſide the Pole is Elevated, the Meaſure of the given *Angle* B, *viz.* 142 *Degrees* 42 *Minutes*, and to this number of *Degrees* and *Minutes* of the Horizon, I bring the Edge of the *Quadrant of Altitude*; then I count in the firſt Meridian from the Pole, the Meaſure of the Side A C 60 *Degrees*; and there I make a Prick, and turn about the *Globe*, till that Prick come to the Edge of the Quadrant of Altitude, ſo is the *Triangle* made on the Globe: The *Degrees* of the Quadrant of Altitude, comprehended between the Firſt Meridian, and the Zenith, being 25 *Degrees*, is the Meaſure of the Side B C: The *Degrees* of the Equinoctial, comprehended between the firſt Meridian, and the Brazen Meridian, being 17 *Degrees* 15 *Minutes*, is the Meaſure of the *Angle* A; and for finding the Meaſure of the *Angle* C, I turn the *Triangle*, as in *Prob.* 7.

## PROB. X.

*Two Angles and the Side comprehended between them given, to find the Reſt.*

*Example.* In the *Triangle* of *Prob.* 7. the *Angles* given are A 17 *Degrees* 15 *Minutes*, and B 142 *Degrees* 42 *Minutes*, the Side comprehended between them is A B 38 *Degrees* 30 *Minutes*; I elevate the Pole to the Complement of the Side A B, which being 38 *Degr.* 30 *Min.* its Complement to 90 *De-*

grees is 51 degrees 30 minutes, ſo is the Zenith diſtant from the Pole 38 degrees 30 minutes; to this 38 degrees 30 Minutes, I ſcrew the *Quadrant of Altitude*, and count in the *Horiz.* from the Interſection of the *Meridian*, with the *Horizon* on that ſide the Pole, is Elevated the Meaſure of the given Angle B, *viz.* 142 degrees 42 minutes, and to this number of degrees and minutes of the *Horizon*, I bring the Edge of the *Quadrant of Altitude*; then I turn about the Globe, till the firſt *Meridian* is diſtant from the *Brazen Meridian* 17 degrees 15 minutes of the *Equinoctial*, which is the Meaſure of the other given Angle; ſo ſhall the Triangle be made on the Globe; and the *Arch of the Quadrant of Altitude*, comprehended between the firſt Meridian and the Zenith, ſhall be the Meaſure of the Side B C 25 degrees, and the Arch of the firſt *Meridian*, comprehended between the Pole and its Interſection with the *Quadrant of Altitude*, ſhall be the Meaſure of the Side A C 60 degrees. The Meaſure of the Angle C is found by Turning the *Triangle*, as in *Prob.* 7.

## PROB. XI.

### *Two Angles and a Side oppoſite to one of them given, to find the reſt.*

*Example.* In the Triangle of *Prob.* 7. the Angles given are A 17 degr. 15 Min. and B 142 degr. 42 Min. the Side given is B C 25 degr. being the Side oppoſite to the Angle A; the Angle A is made at the Pole of the Globe, and meaſured in the *Equator:* Therefore I ſeparate the firſt Meridian from the Brazen Meridian 17 degr. 15 min. ſo doth the Pole repreſent the Angle A; the Angle B is made at the Zenith, and meaſured in the Horizon; therefore I count the Horizon 142 degr. 42 min. and there I make a Prick; to this Prick I bring the Edge of the lower end of the *Quadrant of Altitude*, (not minding to what Degrees of the Meridian the upper end of it is placed) then I count from the upper end of the *Quadrant of Altitude* 25 deg. downwards, the Meaſure of the Side B C, and there I make a Prick, and keeping the lower end of the *Quad. of Altitude* to the Prick made in the Horiz. I ſlide the upper end of it, forwards or backwards, till the Prick on the *Quad. of Altitude* come to the firſt Merid. ſo ſhall the Triangle be made

on

on the *Globe*: Then the Arch of the Brazen Meridian, comprehended between the Pole, and the upper end of the *Quadrant of Altitude*, ſhall be the Meaſure of the Side A B 38 degr. 30 min. and the Arch of the firſt Meridian, comprehended between the Prick on the *Quadrant of Altitude*, and the Pole, ſhall be the Meaſure of the Side A C 60 degr. But the Angle C you muſt find, by turning the Triangle, as in *Prob.* 7.

In the working this *Probleme*, I would have placed the given Side B C 25 degr. upon the Brazen Meridian, between the Pole and Zenith; but then the Angle B (being ſo obtuſe) would have had that Side, which would be Interſected by the *Quadrant of Altitude*, (*viz.* the firſt Meridian) under the Horizon, which the *Quadrant of Altitude* cannot reach.

## PROB. XII.

### *Three Angles given, to find the Sides.*

THis Triangle is taught to be reſolved by Mr. *Palmer* on the Planiſphere, *Book* 3. *Chap.* 19.

It is to be known, (ſaith he) that if you go to the Poles of the three great Circles, whereof your Triangle is made, theſe Poles ſhall be the Angular Points of a Second Triangle, and the two leſſer Sides of this Second *Triangle* ſhall be equal to the two leſſer *Angles* of your firſt *Triangle*: The greateſt Side of the Second *Triangle*, ſhall be the Supplement of the greateſt *Angle* of the Firſt Triangle, (that is, ſhall have as many *degr.* and *min.* as the greateſt *Angle* of the Firſt *Triangle* wanted of 180 *degr.*) See *Pitiſcus Trigonometry*, *Lib.* 1. *Prob.* 61.

This Second *Triangle* therefore (all, whoſe Sides are known from the *Angle* of the Firſt) you ſhall reſolve by *Prob.* 7. and having by that *Probleme* found the *Angles* of the Second *Triangle*, know, that the two leſſer *Angles* of the Second *Triangle* ſhall be ſeveral, and reſpectively equal to the two leſſer Sides of the Firſt *Triangle*, (and the leaſt *Angle* to the leaſt Side, the middle *Angle* to the middle Side) and the greateſt *Angle* of this Second *Triangle*, being Subtracted out of 180 *Degr.* ſhall leave you the Greateſt Side of your Firſt *Triangle*.

*Example.* If the *Angles* be given 142 *Degrees* 42 *Minutes*, 17 *Degrees* 15 *Minutes*, and 25 *Degrees* 24 *Minutes*; and the

Sides be enquired. Draw by aim a rude Scheme of this first *Triangle*, writing in the *Angle* A 17 *deg.* 15 *min.* in B 142 *deg.* 42 *min.* in C 25 *deg.* 24 *min.* ſuppoſing the Sides yet unknown: Then draw under this by aim alſo, a Scheme of the ſecond *Triangle*, ſetting his Baſe Parallel with the Baſe of the firſt, and making the Baſe of the ſecond ſhorter than the Baſe of the firſt. Set alſo B at the *Vertical Angle*, and A C at the Baſe, as in the firſt *Triangle*. Then ſay,

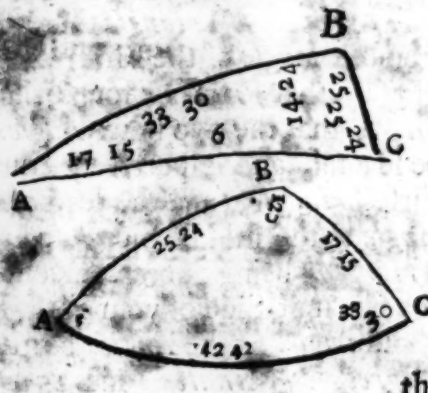
Becauſe A in the firſt *Triangle* is 17 *deg.* 15 *min.* therefore in the ſecond *Triangle* B C (which Subtendeth A) ſhall be 17 *deg.* 15 *min.* and becauſe C in the firſt *Triangle* is 25 *deg.* 24 *min.* therefore in the ſecond *Triangle* the Side A B (which Subtendeth C) ſhall be 25 *deg.* 24 *min.* And becauſe B, the the greateſt *Angle* in the firſt *Triangle*, is 142 *deg.* 42 *min.* therefore in the ſecond *Triangle*, the Side A C (which Subtendeth B) ſhall be the Complement thereof to 180 *Deg. viz.* 37 *deg.* 18 *min.* Write now upon the Sides of this ſecond *Triangle* the Quantities of the Sides, ſo is your ſecond *Triangle* ready to be Reſolved, as by *Prob.* 7. whereby you ſhall find the *Angles* of the ſecond *Triangle*, as I have expreſſed them in the Scheme; A 25 *deg.* C 38 *deg.* 30 *min.* B 120 *deg.*

Now laſtly, I ſay, theſe *Angles* of the ſecond *Triangle* thus found, give me the Sides of the firſt *Triangle*, which I ſeek, in this manner.

| In the ſecond *Triangle.* | In the firſt *Triangle.* |
|---|---|
| A is 25 *Degrees.* | B C is 25 *Degrees.* |
| C is 38. 30. | A B 38. 30. |
| B is 120. 00. | Therefore A C 60. 00. Complement |

of 120 *Degrees* to 180. And thus by all the *Angles* given, we have found out all the Sides, which was required.

Having then the *Angles* of your firſt *Triangle* given, and his Sides now found; you ſhall find his Situation on the Globe thus: Place him as in *Prob.* 7. A B 38 Degrees 30 Minutes between

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the Pole and Zenith, A C 60 *Degrees* in the firſt Meridian, ſeparated from the Brazen Meridian 17 *Degrees* 15 *Minutes* of the Equinoctial, B C 25 Degrees on the Quadrant of Altitude, counted from the *Zenith*, when its lower end is applied to 142 *Deg.* 42 *Min.* of the Horizon; you ſhall ſay, becauſe the *Eaſt* Point of the Horizon is the Pole of the Arch A B, therefore at the *Eaſt* Point of the Horizon ſhall ſtand the *Angle* C, which A B Subtendeth: Then number from the Quadrant of Altitude 90 *Deg.* on the Horizon Eaſtwards, and there is the Pole of the Arch B C: Therefore there ſhall ſtand the *Angle* A, which B C Subtendeth. Theſe 90 *Deg.* will end at 37 *Deg.* 18 *Min.* counted from the *Eaſt* Point of the Horizon *Northwards*; then count in the Equator from the firſt Meridian 90 *Deg.* which will end under the Horizon, and there make a Prick; for there is the Pole of the Arch or Side A C. Therefore at that Prick ſhall ſtand the *Angle* B, which A C Subtendeth.

Here you ſee your Second *Triangle*, made by the Poles of the Firſt, adjoining to the *Eaſt* Point of the Globe; only the Side A B is wanting: To get that, make a Prick upon the Globe againſt the 37 *Deg.* 18 *Min.* from the *Eaſt* Point of the *Horiz. Northwards*, found before, to repreſent the *Angle* A: Then turn about the Globe and Quadrant of Altitude, till that Prick, and the Prick made before for the *Angle* B, are both at once cut by the Side of the Quadrant of Altitude, and you will find 25 *Deg.* 24 *Min.* of the Quadrant of Altitude, comprehended between the two Pricks, for the Meaſure of the Side A B.

## PROB. XIII.

*How to let fall a* Perpendicular *that ſhall Divide any Oblique Spherical Triangle, into two Right Angled Spherical Triangles.*

THis *Probleme* is much uſed, when an *Oblique Triangle* having two Sides and an *Angle* given, is to be Solved by the Canon of *Sines* and *Tangents*: But by the Globe it may be Solved without it, as was ſhewed *Prob.* 8, 9. Yet becauſe Letting fall a *Perpendicular*, is ſo frequent in all Authors that treat of *Trigonometry*, I have inſerted this Probleme alſo.

In

In the *Oblique Triangle* of the former Problemes, there is given the Sides A B 38 $\frac{1}{3}$ *deg.* and B C 25 *deg.* and the *Angle* C 25 *deg.* 24 *min.* It is required to let fall a *Perpendicular*, as B *a* from the *Angle* B, upon the Base A C, and to know both the Measure of this *Perpendicular*, and the parts it divides the Base into.

Therefore Elevate the Pole of the Globe above the *Horizon* so much as is the Measure of the *Angle* C, which in the *Example* is 25 *deg.* 24 *min.* and bring the Intersection of the first Merid. with the *Equinoctial*, to the *East* Point in the *Horizon*; so shall the *Angle*, at the *East* Point of the *Horizon*, comprehended between the *Horizon*, and the first Meridian, be equal to the *Angle* C; then count in the first Meridian, from the *East* Point of the *Horizon*, the Measure of the Side B C 25 *deg.* and having the Quadrant of Altitude screwed to the *Zenith*, bring the Graduated Edge of it to these 25 *deg.* so shall the Arch of the *Horizon*, comprehended between the *East* Point and the lower end of the Quadrant of Altitude, be the number of *deg.* that the *Perpendicular* falls upon the Base, counted from the *Angle* C to *a*, which in this *Example* is 21 $\frac{3}{4}$ *deg.* and the Arch of the Quad. of Altitude, comprehended between the *Horizon* and the first Meridian, is the Measure of the *Perpendicular* B *a* 11 *deg.*

And thus, by letting fall this *Perpendicular*, you have two Right Angled Spherical Triangles made; the one B *a* C, wherein is found C *a* 21 $\frac{3}{4}$ *deg.* B C 24 *deg.* B *a* 11 *deg.* C 25 *deg.* 24 *min.* and *a* the *Right Angle*: There remains only the *Angle* B unknown, which you must find, by turning the *Triangle*, as was taught, *Prob.* 1. The other *Right Angled Spherical Triangle* made, is B *a* A, wherein is found A *a*, Complement of 21 $\frac{1}{4}$ *deg.* to 60 *deg.* (the whole Base before given) 38 $\frac{1}{4}$ *deg.* A B 38 *deg.* 30 *min.* B *a* 11 *deg.* and *a* the *Right Angle*, which is more than enough to find the *Angles* A and B, as was shewed in the *Præface*, *Theorem* 1.

*The End of the Sixth Book.*

AN

# AN APPENDIX, Shewing the EXPLANATION and USE OF THE PTOLOMAICK SPHERE.

## PRÆFACE.

HAving for ſome time paſt Made and Sold Ptolomaick Spheres, I have found ſome of my Cuſtomers much deſirous of ſomething that might Inſtruct them in the Uſe of them; And to comply with their Deſires, I have publiſht this Appendix; which though it be ſmall, yet conſidering what hath been taught of the Uſe of the Globes, it is copious enough for the Uſe of the Ptolomaick Sphere: For the Globe and Sphere are Inſtruments of ſo near a Kin, that Readers of Aſtronomy many times indifferently Name either the one or the other for the ſame purpoſe.

There hath indeed a Book been publiſht of the Uſe of the Ptolomaick Sphere; but the Sphere that Book was made for, differs from the Spheres Vulgarly made: For that

*that* Sphere *was purposely made for Prince* Henry, *eldest Son to King* James *of blessed Memory, and no cost spared to make it either Useful or Beautiful; as may yet be seen by the Instrument it self; it being lately in the possession of Sir* Jonas More *in the* Tower *of* London, *and therefore would be too dear for general Sale. But the* Spheres *for which this* Appendix *is designed, is the Common* Ptolomaick Sphere; *by which* Sphere, *after a Practitioner grows a little familar with the Constitution of the* Heavens, *he may sufficiently conceive how the* Zodiacal *and* Ecliptical *motions of the* Planets *are made: And also in what Places of their several* Orbs *their* Perigeums *and* Apogeums *will fall out.*

### *What a* Sphere *is.*

I Told you in the firſt Chapter of the firſt Book, that a *Globe* according to the *Mathematical* definition is a perfect and exact round Body, contained under one Surface. The definition of a *Sphere* is the ſame. So then, the *Globe* and *Sphere* as they are *Geometrick* Bodies are alſo the ſame. Yet, as they are *Aſtronomical* Inſtruments there is a difference in them: For as a *Sphere* is an *Aſtronomical* Inſtrument, it is a complication of material Circles only, ſo fitted together that they repreſent all the Imaginary Circles and Motions of the Eighth *Sphere*, and the Circles and Motions of all the *Planets* about the *Earth*. Therefore on this material *Sphere* you can neither have all the *Conſtellations* and *Stars*, nor the ſhape of the *Earth*, *Waters*, *Towns*, &c. depicted: Becauſe of the vacuities between the ſeveral Circles. Yet is the *Sphere* applicable to almoſt all the *Aſtronomical* Uſes the *Celeſtial* and *Terreſtrial Globes* are: And in ſome caſes more apt to repreſent the Order and Appearance of the *Planetary Orbs*. For thereon have you repreſented the *Zodiack*, the *Equinoctial*, the *Colures*, the *Tropicks*, the *Polar Circles*, the *Meridian*, the *Horizon*, *Verticle Circle*, *Hour-Circle*, &c. juſt in the ſame manner and order they are on the *Celeſtial* and *Terreſtrial Globe*; and therefore I refer you to the ſeveral definitions in the firſt Book: Only with this difference, that where you find *Globe* you read *Sphere*.

And as the Circles of the *Globe* and *Sphere* are the ſame, ſo is the manner of working with the *Globe* and *Sphere* the ſame; and the Precepts you find in the ſeveral Problems throughout this Book that relate only to the Circles, you find in the *Sphere*, ſerve indifferently and in the ſame manner for the *Sphere*, if (as was ſaid) you only read *Sphere* where you find *Globe*. This I ſhall paſs by without farther inlarging on, becauſe it is ſo plain: and ſhall come to ſhew you in what reſpect a *Sphere* is more apt to repreſent the Order and Appearance of the *Planetary Orbs* than a *Globe* is. And that is, becauſe a *Sphere* is complicated only of Lath-like Circles to repreſent each *Orb*, and is not an intire *Orb* as a *Globe* is, ſo that you may ſee the ſeveral Fabrications that are made within it. But if the *Sphere* were made of intire *Orbs* you could ſee only the outmoſt *Orb*, not any of the inner Fa-

cations: as we may see in an *Onyon*, which though it be made up of several *Orbs* the one within another, as the whole *World* is of many *Heavens* or *Orbs* one within another: Yet can we only see the utmost *Orb* or Scale of the *Onyon*, that wrapping up and hiding all the other from our Eyes. So that all the *Orbs* (as we must call them) of the *Sphere* are not real *Orbs*, but serve only for the representation of *Orbs*.

Besides, you have every *Planet* represented in an *Orb* by it self, and that in the same Order that it is ranked in Heaven.

As First the outmost *Orb* of all, which represents the *Orb* of the *Eighth Heaven*, or *Starry Heaven*, consists of the two *Colures*, which are those two great Circles that cross each other at Right Angles in the *Poles* of the *World*, and are divided from the *Equinoctial* each way into 90 Degrees, and numbred with numerical Figures from the *Equinoctial* towards either *Pole* with 10, 20, 30, to 90.

*Seconaly*, The *Equinoctial*, which is a Circle lies exactly in the middle between the two *Poles*, and Cuts the *Colures* at Right Angles, as it is also Cut by them. It is divided into 360 Degrees numbred from the *Vernal Colure Eastwards*, with 10, 20, 30, to 360.

*Thirdly*, The *Zodiack*, which is a broad Circle that lies Oblique or aslope from the *Equinoctial*, making an *Angle* of $23\frac{1}{2}$ Degrees with it. It is Cut by the *Equinoctial* and its *Colures* in two Points, *viz.* in ♈ and ♎, and by the *Tropical Colure* in two Points, *viz.* in ♋ and ♑. In the middle of this broad Circle lies the *Ecliptick* Line, which is divided into twelve equal Parts, called *Signs*, as *Aries*, *Taurus*, *Gemini*, &c. to *Pisces*, and ornamented with the Picture of each *Sign*, as to ♈ you have the Picture of a Ram, to ♉ a Bull, and so of the rest. Each *Sign* is again divided into 30 Degrees, and numbred from the beginning of the *Sign* towards the end with 10, 20, to 30. It hath about 5 Degrees of bredth on either side the *Ecliptick*, for the Swerving of the *Planets* from the true *Ecliptick* Line.

*Fourthly*, The two *Tropicks* are smaller Circles, commonly made of Wyer, that Decline $23\frac{1}{2}$ Degrees from either side the *Equinoctial*, and therefore bound the *Ecliptick*. They Cut the *Colures* at *Right Angles*, as also they are Cut by the *Colures*.

*Fifthly*, The *Arctick* and *Antarctick* Circles, are two Circles yet smaller than the *Tropicks*, also made of Wyer, that Decline

$23\frac{1}{2}$ De-

$23\frac{1}{2}$ Degrees from either *Pole*: Theſe alſo Cut the *Colures* at *Right Angles*, as they are alſo Cut by the *Colures*.

This *Machine* is called the *Eighth Heaven*, Becauſe it ſerves to repreſent the *Eighth Heaven*: But its Motion is performed upon its two *Poles*, through which runs a ſtraight Wyer, to repreſent the *Axis* of the *World*, and therefore is called the *Axis*: Next within the *Eighth Heaven*, is placed the *Sphere* or *Heaven* of *Saturn*. It is repreſented by three Circles: Two of them Cut each other at *Right Angles* in their *Poles*, even as the *Colures* do. But for diſtinction from the *Colures* ſhall be called *Upright-Circles* when ever I name them with relation to the *Sphere* of any of the *Planets*: The other Circle Cuts theſe *Upright Circles*, and is alſo Cut by them at *Right Angles* in the middle between their two *Poles*: as the *Equinoctial* does the *Colures*: which Circle I ſhall hereafter call the *Flat Circle*, when I name it with relation to the *Sphere* of any of the *Planets*: on this Circle is writ *Sphera Saturni*: and hard by it is fitted on one of the *Upright Circles*, a *Braſs* plate with a Button on it, which button repreſents the *Star* or *Planet* ♄, it ſelf: it is made to ſlide *Northwards or Southwards* on the *Upright Circle*, becauſe ♄ oft alters its *Latitude* from the *Ecliptick*, and conſequently its *Declination*: And by this means you may ſlide it to any *Latitude*, or *Declination* you ſhall ſee cauſe for.

Next within the *Sphere* of *Saturn*, is placed the *Sphere* of *Jupiter*, which is repreſented by ſuch Circles, and a ſliding Button, even as the *Sphere* of *Saturn* is.

Next within the *Sphere* of ♃, is placed the *Sphere* of ♂, within the *Sphere* of ♂, the *Sphere* of ☉, within the *Sphere* of ☉, the *Sphere* of ♀, within the *Sphere* of ♀, the *Sphere* of ☿, within the *Sphere* of ☿, the *Sphere* of ☾, all repreſented as is the *Sphere* of ♄, and all performing their Motions upon their own *Poles*, and the *Axis* of the *World*.

Within the *Sphere* of ☾, is placed a ſmall *Globe* of the *Earth*, whereon is deſcribed all the Countries of the *Earth*, and the Names of ſo many inſerted, as the Magnitude of that *Globe* is conveniently able to receive.

This Ball is fixed in the middle of all the *Heavens*, and about it, as about a common Center, they all perform their various Motions.

This *Machine*, or *Fabrick*, or *Model* of the Viſible *World*,

(which you will) is Hung in a *Braſen Meridian*, as a *Globe* is See § 4. of Chap. 1. Book 1. And this *Meridian* is let into a Wooden *Horizon* as in § 5. of the ſame Chap. and Book.

The *Quadrant of Altitude*, *Hour-Circle*, and its *Index*, *Nautical* Compaſs, and *Semi-Circle of Poſition*, which belong to a *Sphere*, are in all reſpects the ſame with thoſe belonging to a *Globe*, and therefore I refer you to § 6, 7, 8, 9. of the ſame Chapter.

But becauſe all Problemes that have relation to any of the *Planets*, or their *Spheres*, are more aptly and properly performed by the *Sphere* than the *Globe* (becauſe you have a particular *Heaven* aſſigned each particular *Planet*, and by reaſon of the openneſs of every *Sphere* you may ſee the more natural Situation and poſition of them all at once.) Therefore I here produce two Problemes which may ſerve as *Examples* to direct you in all Operations, that you may meet with of this Nature. And firſt,

## PROB. V.

*To Set the* Sphere *and all the* Planets *in a Poſition agreeable to the whole Frame of the Viſible* World, *at any given Time.*

Firſt Rectifie the *Eighth Sphere*, *Horizon*, *Quadrant of Altitude*, and *Hour Index* to your Elected Time. Then by an *Ephemeris* find the true Places of the *Planets* in *Heaven* for that Time: And bring each reſpective *Node* which repreſents each reſpective *Planet*, to thoſe ſeveral Places you find them in the *Ephemeris*; ſo ſhall the *Planets* appear in the *Sphere* juſt in the ſame Place they are in Heaven.

*Example.*

I would Place the *Planets* on the *Sphere* to Agree with the Places they have at this preſent Time, *viz.* 1669. *Sep.* 17. juſt at Noon, in the Latitude of 51½ Degrees. Therefore I firſt Rectifie the *Sphere* to the given Time, as by Prob. 2. of the 2d. Book, then in the *Ephemeris* I find the Place of the *Sun* ♎ 4 Degrees 42 Minutes, therefore I bring the little *Golden Node* on the *Suns*

*Suns Orb* to ♎ 4 Degrees 42 Minutes, ſo is that little Golden *Node* Placed in the *Sphere* to agree with the Place the *Sun* hath in *Heaven*: then ſearching the *Ephemeris* again for the *Moons* Place, I find She is in ♏ 0 Degrees 36 Min. and hath 10 Minutes *North Latitude* from the *Eclip.* Therefore I bring the little Silvered ☾ in the *Moons Orb*, to ♏ 0 Degrees 36 Min. of the Eighth *Sphere*, and ſlide the Silver ☾ 10 Minutes to the *Northwards* of the *Ecliptick* Line, ſo is that Silvered *Moon* Placed in the *Sphere* to agree with the Place the *Moon* hath in *Heaven.* Then ſearching in the *Ephemeris* for the Place of ♄, I find ♄ in 19 Degrees 19 Minutes of ♒, and hath 1 Deg. 27 Min. *South Latitude* from the *Ecliptick*: Therefore I bring the little *Node* or Ball upon the *Sphere* of ♄, to ♒ 19 Degrees 19 Minutes of the Eighth *Sphere*, and ſlide the Button or *Node* which repreſents ♄ 1 Deg. 27 Min. to the *Southwards* of the *Ecliptick* Line: So is that *Node* or Ball Placed in the *Sphere* to agree with the Place ♄ hath in *Heaven*. The like way I uſe, to Place ♈, ♂, ☿, ♀, in the *Sphere*, to agree with their Places in *Heaven.*

The Eighth *Sphere* and the *Nodes* repreſenting all the *Planets*, being thus poſited, becomes an actual Repreſentation of the whole Frame of the Viſible *World*: And all the *Spheres* of the *Planets* by being turned about with the Eighth *Heaven*, perform a *Diurnal* Mutation, and ſhew all the Various Appearances they will have in *Heaven*, for that Day, *viz.* The Time of their Riſing and Setting, as by Prob. 7, 8. Their *Altitudes* as by Prob. 6. Their *Amplitudes* as by Prob. 10. Their *Azimuths* and *Almicanters* as by Prob. 22, 23. Their *Right Aſcenſions* as by Prob. 26. Their *Declinations* as by Prob. 2. Their *Oblique Aſcenſions* and *Oblique Deſcenſions* as by Prob. 28. Their *Diurnal* and *Nocturnal Arches* as by Prob. 38 of the Second Book: Their Configurations or *Aſpects* among themſelves, and their Circulations about the *Earth.*

## PROB. II.

### *How* Eclipſes *are Demonſtrated by the* Sphere.

YOU muſt know that the *Moon* moves not conſtantly in the *Ecliptick*, as the *Sun* does, for if She did, there would two *Eclipſes* happen every Month; the one of the *Sun*, and the other of the *Moon*, but She moves in a Circle

Circle Oblique to the *Ecliptick* about 5 Deg. even as the *Ecliptick* is Oblique to the *Equinoctial* 23½ Deg. And as the *Ecliptick* Cuts the *Equinoctial* only in two Oppoſite points, *viz.* ♈ and ♎ So the Circle of the *Moon* Cuts the *Eclip.* only in two Oppoſite Points, which are called, The *Dragons-Head* (thus characterred ☊) and the *Dragons-Tail* (thus characterred ☋) That point which interſects the *Ecliptick* on the *Eaſtern* ſide, and proceeds *Northwards*, is called the *Dragons-Head*; and the Oppoſite Point the *Dragons-Tail*. Theſe Points conſtantly ſhift their Places, and have a *Retrograde* Motion through the *Ecliptick* in almoſt 19 Years: And when the *Sun* and *Moon* meet in or near either of theſe Points, or oppoſe each other in or near theſe Points, an *Eclipſe* happens; if they meet, the *Sun* is *Eclipſed*, becauſe the dark ſolid Body of the *Moon*, interpoſes between our Sight and the *Sun*, and ſo hides him: If they oppoſe each other, the *Moon* is *Eclipſed*, for then the dark ſolid Body of the *Earth*, interpoſes between the *Sun* and the *Moon*, and ſo hinders the Light of the *Sun* from falling upon the *Moon*, which hath no Light of Her own but what She receives from the *Sun*.

But that you may the more plainly ſee the Demonſtration of *Eclipſes* by the *Sphere*: Place the Golden Ball repreſenting the *Sun*, and the *Silvered* ☾ repreſenting the ☾ in two Oppoſite Points of the *Ecliptick*; ſo ſhall the *Sun*, the *Earth*, and the *Moon* be all in a ſtraight Line, and the *Moon Eclipſed*; becauſe the *Earth* lying directly between the *Sun* and the *Moon*, keeps the Light of the *Sun* off the *Moon*, and ſo becomes a Shadow to Her, which of Her ſelf hath no Light but what ſhe receives from the *Sun*, as was ſaid before; and the *Moon* will continue Darkned, till She comes out of the *Earth's* Shadow.

Again, Place the *Sun* and *Moon* in the ſame *Sign* and Deg. of the *Ecliptick*, and imagine as before, a Light to come from the *Sun* in the *Sphere*, then will you ſee the reaſon why the Light of the *Sun* cannot fall upon the *Earth*, *viz.* becauſe the *Moon* is interpoſed betwixt the *Sun* and the *Earth*, and ſo Shadows the *Earth* by keeping the Light of the *Sun* off it, which to us appears as if the *Sun* were Darkned, though indeed it is only the *Earth* that is deprived of the *Sun's* Light by the interpoſition of the *Moon*, as aforeſaid.

But becauſe an *Eclipſe* happens not, as was ſaid before, but when the *Sun* and *Moon* ſeems to meet or oppoſe one another in

or

or near the *Dragons-Head* or *Tail*; therefore by the following Rule you muſt learn to find the Place of the *Dragons-Head* and *Tail*, that ſo by the *Suns* and *Moons* Progreſs through the *Ecliptick*, you may know when the *Sun* and She will Meet or Oppoſe each other in or near thoſe Points, and accordingly fore-know an *Eclipſe*.

### *How to find the place of the* Dragons-Head *and* Tail.

The *Dragons-Head* and *Tail* finiſh a *Retrograde Revolution* through the *Ecliptick* in 18 Years 224 Days and 3 Hours; So that in one Year it moves 19 Deg. and 20 Min. in a Month 1 Deg. 36 Min. and in one Day 3 Min. Therefore if for any Time paſt or to come, you know the Place of the *Dragons-Head* or *Tail* you may Add or Subtract 19 Deg. 20 Min. for every Year, 1 Deg. 36 Min. for every Month, and 3 Min. for every Day, and the Remainder ſhall be the Deg. and Min. that the *Dragons-Head* or *Tail* is in.

### *Example.*

It is to be ſuppoſed that I remember the Place of the *Dragons-Head* to be in ♍ 12 Deg. 20 Min. I would know the Place of the *Dragons-Head* for this preſent Day, *Sept.* 17. 1669. Since *January* 1. 1663. there is 6 Years 8 Months and 17 Days paſt: Therefore for each Year I allow 19 Deg. 20 Min. which makes 116 Deg. for the 8 Months I allow 8 Deg. and 8 times 36 Min. *viz.* 12 Deg. 48 Min. more, which makes 128 Deg. 48 Min. and for the 17 Days I allow 51 Min. which,

116---00
12----48
51 added together, make
129 Deg. 39 Min.

which Subtracted (becauſe the *Dragons-Head* moves contrary to the Succeſſion of *Signs*) from ♍ 12 Deg. 20 Min. leaves ♉ 2 Deg. 41 Min. for the Place of the *Dragons-Head Sept.* 17. 1669. The Place of the *Dragons-Tail*, as was ſaid before, is the Deg. and Min. of the *Ecliptick* Oppoſite to that of the *Dragons-Head*, which in this *Example* is ♏ 2 Deg. 41 Min.

Here

Here follows the

# ANCIENT STORIES

Of the ſeveral

## *STARS* and *CONSTELLATIONS.*

Shewing the Poetical Reaſons why ſuch Various Figures are placed in *HEAVEN.*

## *Collected from* Dr. Hood.

### And Firſt,

### *Of the* Northern Conſtellations.

URSA MINOR. This *Conſtellation* hath the Prehemi-nence, becauſe it is neareſt of all the reſt unto the *North Pole*; and is called of the *Greeks Arctos*, whereupon the *Pole* is called the *Pole Artick*, for that it is near unto that *Conſtellation*. It is alſo called *Helice Minor*, becauſe of the ſmall Revolution which it maketh round about the *Pole*: or rather of *Elice*, a Town in *Arcadia*, wherein *Caliſto* the *Great Bear*, and Mother to the leſs, was bred. It is called *Cynoſura*, becauſe this *Conſtellation*, though it carry the name of a *Bear*, yet it hath the Tail of a *Dog*: Laſt of all, it is termed *Phœnice*, becauſe that *Thales*, who firſt gave the name to this *Conſtellation*, was a *Phœnician*: And therefore the *Phœnicians* being taught how to uſe it in their *Navigations*, did call it by the name of the Country wherein *Thales* was born. It conſiſteth of ſeven *Stars*, which the Latines call *Septentriones*; becauſe by their continual Motion thoſe ſeven *Stars* do as it were wear the *Heavens*. The *Spaniards* call them all *Boſina*, that is an *Horn*; becauſe they may be very well brought into that Form; whereof that which is in the end of the Tail, is called the *Pole-ſtar*, by reaſon of the nearneſs thereof unto the *Pole* of of *World*: for it is diſtant (according to the Opinion of moſt) from the true *Pole*, but three Degrees 30 Minutes. The *Arabians* call

call it *Alrukaba*: And of the *Scythians* it is ſaid to be an *Iron Nail*, and is Worſhipped by them as a God. The two *Stars* that are in the ſhoulders of the *Bear*, are called the *Guards*, of the *Spaniſh* word *Guardare*, which is to behold; becauſe they are diligently to be lookt unto, in regard of their ſinglar Uſe which they have in Navigation.

The reaſon why this *Conſtellation* was brought into the *Heavens* is diverſly ſet down, and firſt in this manner: *Saturn* having received of the Oracle that one of his Sons ſhould baniſh him out of his Kingdom, determined with himſelf to kill all the Men Children that he ſhould beget: whereupon he gave command to *Ops* his wife, being then great, that ſhe ſhould ſhew him the Child ſo ſoon as ever it was born: But ſhe bringing forth *Jupiter*, and being greatly delighted with his hair, gave the Child unto two Nymphs of *Crete*, dweling in the Mount *Dicte*; whereof this was one, and was called *Cynoſura*, the other was *Helice*.

*Jupiter* after that (according to the Oracle) he had bereft his Father of his Kingdom, in recompence of their pains and courteſie, tranſlated them both into the *Heavens*, and made of them two *Conſtellations*: The *Leſſer Bear*, and the *Greater Bear*.

Otherſome ſay that it was *Arcas* the Son of *Caliſto*, and they tell the Tale on this manner: *Caliſto* a Nymph of ſingular beauty, Daughter to *Lycaon* King of *Arcadia*, induced by the great deſire ſhe had of Hunting, became a follower of the Goddeſs *Diana*. After this, *Jupiter* being Enamored with her Beauty, and out of hope, by reaſon of her Profeſſion, to win her Love in his own Perſon, counterfeited the ſhape of *Diana*, Lay with *Caliſto*, and got her with Child, of whom was born a Son, which was called *Arcas*. *Diana*, or rather *Juno*, being very much offended herewith, turned *Caliſto* into a *Bear*. *Arcas* her Son at the Age of Fifteen, Hunting in the Woods by chance ighted upon his Mother in the ſhape of a *Bear*: Who knowing ier Son *Arcas*, ſtood ſtill that he might come near unto her, and ot be afraid: But he fearing the ſhape of ſo cruel a Beaſt, bent his Bow of purpoſe to have ſlain her: Whereupon *Jupiter* to prevent the miſchief tranſlated them both into *Heaven*, and of them made two ſeveral *Conſtellations*: Unto the *Leſſer Bear*, there belongs but one Star unformed.

2. URSA MAJOR, the *Greater Bear*, called alſo of the *Greeks*, *Arctos*, and *Helice*, conſiſteth of twenty ſeven *Stars*; among the

which, those seven that are in the Hinder part and Tail of the *Bear*, are most observed; the *Latins* call them *Plaustrum*; and of our Men they are called *Charles Wayn*; because the *Stars* do stand in such sort, that the three which are in the Tail resemble the Horses, and the other four which are in the flank of the *Bear*, stand (after a manner) like the Wheels of a Wagon, or Chariot; and they are supposed by some to be greater than the *Sun*. The reason of the Translation of this *Constellation* into the *Heaven*, is at large set down in the other *Constellation*, and therefore needs not here to be repeated. This *Constellation* was first invented by *Nauplius*, the Father of *Palamedes* the *Greek*: And in great use among the *Grecians*, and this is to be noted both in this and the former *Constellation, that they never Set under the* Horizon *in any part of* Europe: which tho' it fall out by reason of their Situation in the *Heavens*, yet the Poets say, that it came to pass through the displeasure and hatred of *Juno*, who for that she was by *Calisto* made a Cuckquean, and they notwithstanding (as she took it) in despight of her were translated into *Heaven*, requested her Brother *Neptune*, that he should never suffer those *Stars* to Set within his Kingdom. To which request *Neptune* condescended; so that in all *Europe* they never come near unto the Sea, or touch the *Horizon*. If any one marvel, that (seeing She hath the form of a *Bear*) She should have a Tail so long; Imagine that *Jupiter* fearing to come too nigh unto her Teeth, laid hold on her Tail, and thereby drew her up into *Heaven*; so that She of her self being very weighty, and the distance from the *Earth* to the *Heaven* very great, there was great likelihood that her Tail must stretch. The Unformed *Stars* belonging to this *Constellation* are eight.

3. DRACO, the *Dragon*, of some named the *Serpent*; of others the *Snake*, by the *Arabians*, *Aben*; and by *Juntinus Florentinus*, *Drago*, because he windeth his Tale round about the *Ecliptick Pole*; it containeth one and thirty *Stars*. This was the *Dragon* that kept the Golden Apples in the Orchard of the *Hesperides*, (and now thought to be the Islands of *Cape de Virde*) and for his diligence and watchfulness, was afterwards translated into *Heaven*: Yet others say that he came into *Heaven* by this occasion; when *Minerva* withstood the *Giants* fighting against the *Gods*; they to terrifie her threw at her a mighty *Dragon*; but she catching him in her Hands, threw him presently up into

*Heaven*

*Heaven* and placed him there, as a Memorial of that her reſiſtance. Others would have it to be the *Serpent Python*, whom *Apollo* ſlew, after the Deluge.

4. CEPHEUS containeth in him eleven *Stars*, and hath two unformed. This was a King of the *Æthiopians*, and Husband unto *Caſſiopeia*, and Father of *Andromeda*, whom *Perſeus* Married, He was taken up into *Heaven*, with his Wife and Daughter, for the good deeds of *Perſeus* his Son in Law; that he and his whole Stock might be had in remembrance for ever. The *Star* which is in his Right Shoulder, is called by the *Arabians* *Alderahiamin* (i. e.) his Right Arm.

5. BOOTES, *the Driver of the Oxen* (for ſo I ſuppoſe the name to ſignifie, rather than an *Herdſman*; for he hath not his name becauſe he hath the care of any Cattel, but only becauſe he is ſuppoſed to drive *Charles his Wayn*, which is drawn by three Oxen) He is alſo called *Arctophilax*, the keeper of the *Bear*, as tho' the care of Her was committed to him: This *Conſtellation* conſiſteth of two and twenty *Stars*. Some will have *Bootes* to be *Arcas*, the Son of her who before was turned into the *Great Bear*; and they tell the Tale thus: *Lycaon* the Father of *Caliſto*, receiving *Jupiter* into his Houſe as a Gueſt, took *Arcas* his Daughters Son, and cut him in pieces, and among other Services, ſet him before *Jupiter* to be eaten: For by this means he thought to prove if his Gueſt were a *God*, as he pretented to be. *Jupiter* perceiving this heinous fact, overthrew the Table, fired the Houſe with Lightning, and turned *Lycaon* into a Wolf: But Gathering, and ſetting together again the Limbs of the Child, he committed him to a Nymph of *Ætolia* to be kept: *Arcas* afterwards coming to Mans Eſtate, and hunting the Woods, lighted at unawares upon his Mother, transform'd by *Juno* into the ſhape of a *Bear*, whom he purſued into the Temple of *Jupiter Lycæus*, whereunto by the Law of the *Arcadians*, it was death for any Man to come. For as much therefore as they muſt of likelihood be both ſlain, *Caliſto* by her Son, and he by by the Law; *Jupiter* to avoid this miſchief, of meer pity took them both up into *Heaven*. Unto this *Conſtellation* belongeth but one *Star* unformed, and it is between the Legs of *Bootes*, and by the *Grecians* it is called *Arcturus*, becauſe of all the *Stars* near the Great *Bear* named *Arctos*, this *Star* is firſt ſeen near her Tail in the Evening. The Poetical invention is thus.

*Icarus* the Father of *Erigone*, having received of the God *Bacchus*

*Bacchus* a Flagon of Wine, to declare how good it was for mortal Men, travelled therewith into the Territories of *Athens*, and there began to Carouse with certain Shepherds; they being greatly delighted with the pleasantness of the Wine, being a new kind of Liquor, began to draw so hard at it, that ere they left off, they were past one and thirty; and in the end, were fain to lay their Heads to rest. but coming unto themselves again and finding their Brains scarce in good temper, they killed *Icarus*, thinking indeed that he had either Poysoned them, or at the leastwise made their Brains intoxicated. *Erigone* was ready to die with grief, and so was *Mera*, her little Dog. But *Jupiter* to allay their grief, placed her Father in *Heaven*, between the Legs of *Arctophylax*.

6. CORONA BOREA, the *Northern Garland*, consisteth of Eight *Stars*; yet *Ovid* saith, that it hath Nine. This was the *Garland* that *Venus* gave unto *Ariadne*, when she was Married unto *Bacchus*, in the Isle *Naxus*, after that *Theseus* had forsaken her: Which *Garland*, *Bacchus* placed in the *Heaven*, as a token of his Love. *Novidius* will have it to be the *Crown of the Virgin Mary*.

7. ENGONASIS, This *Constellation* hath the name, because it is expressed under the shape of a Man kneeling upon the one Knee, and is therefore by the *Latines* called *Ingeniculum*. It containeth nine and twenty *Stars*, and wanteth a proper Name, because of the great diversity of Opinions concerning the same. For some will have it to be *Hercules*, that mighty Conqueror, who for his 12 labours was thought worthy to be placed in *Heaven*, and nigh unto the *Dragon* whom he overcame. Others tell the Tale thus: That when the *Tytans* fought against the *Gods*, they for fear of the *Gyants*, ran all unto the one side of the *Heaven*: Whereupon the *Heaven* was ready to have fallen, had not *Hercules* together with *Atlas*, set his Neck unto it, and staied the fall: And for his desert, he was placed in *Heaven*.

8. LYRA, the *Harp*, it containeth ten *Stars*; whereof thus goeth the Fable. The River *Nilus* swelling above his Banks, overflowed the Country of *Egypt*; after the Fall whereof there were left in the fields divers kinds of living things, and amongst the rest a *Tortoise*; *Mercury*, after the flesh thereof was consumed, the sinews still remaining, found the same, and striking it, he made it yield a certain sound; whereupon he made an *Harp* like unto it, having three Strings, and gave it unto *Orpheus* the

Son

Son of *Caſſiopea*. This *Harp* was of ſuch excellent Sound, that Trees, Stones, Fowls and wild Beaſts are ſaid to follow the ſound thereof. After ſuch time therefore that *Orpheus* was ſlain by the Women of *Thrace*, the *Muſes* by the good leave of *Jupiter*, and at the requeſt of *Apollo*, placed this *Harp* in *Heaven*. *Novidius* will have it to be the *Harp* of *David*, whereby he pacified the evil ſpirit of *Saul*. This *Conſtellation* was afterwards called *Vultur Cadens*, the *Falling Gripe*: And *Falco* the *Falcon*; or *Timpanum* the *Timbrel*.

9 OLOR, or *Cygnus* the *Swan*, called of the *Chaldæans Adigege*; It hath ſeventeen *Stars*: Of this *Conſtellation* the Poets Fable in this manner. *Jupiter* being overtaken with the Love of *Lada* the Wife of *Tyndarus* King of *Oebilia*, and knowing no honeſter way to accompliſh his deſire, procured *Venus* to turn her ſelf into an *Eagle*, and himſelf he turned into the ſhape of a *Swan*. Flying therefore from the *Eagle*, as from his natural Enemy, that earneſtly purſued him, he lighted of purpoſe in the Lap of *Lada*, and, as it were, for his more ſafety, crept into her Boſome. The Woman not knowing who it was under that ſhape, but holding (as ſhe thought) the *Swan* faſt in her Arms, fell aſleep: In the mean while *Jupiter* enjoyed his Pleaſure; and having obtained that he came for, betook him again unto his Wings; and in memorial of his Purpoſe (attained under that Form) he placed the *Swan* among the *Stars*.

*Ovid* calleth this *Conſtellation Milvius*, the *Kite*, and telleth the Tale thus. The *Earth* being greatly offended with *Jupiter*, becauſe he had driven *Saturn* his Father out of his Kingdom, brought forth a Monſtrous *Bull*, which in his hinder parts was like a Serpent; and was afterwards called the *Fatal Bull*, becauſe the *Deſtinies* had thus decreed, that whoſoever could ſlay him, and offer up his entrails upon an Altar, ſhould overcome the Eternal Gods. *Briareus* the mighty *Gyant*, and ancient Enemy of the Gods, overcame the *Bull*, and was ready to have offered up his entrails according to the decree of the *Deſtinies*: But *Jupiter* fearing the event, commanded the Fowls of the *Air* to ſnatch them away: Which altho' to their power, they endeavour'd, yet there was none of them found ſo forward and apt to that action as the *Kite*, and for that cauſe he was accordingly rewarded with a Place in *Heaven*. Some call this *Conſtellation Avis*, that is, the *Bird*: Others call it *Vultur Volans*, the *Flying Grype*: It is alſo called *Gallina*, the *Hen*. Unto this *Conſtellation* do belong two unformed *Stars*.

10. CAS-

10. CASSIOPEIA, She conſiſteth of thirteen *Stars*. This was the Wife of *Cepheus*, and the Mother of *Andromeda*, whom *Perſeus* married, and for his ſake was tranſlated into *Heaven*, as ſome write. Others ſay that her beauty being ſingular, ſhe waxed ſo proud, that ſhe preferred her ſelf before the *Nereides*, which were the *Nymphs* of the *Sea*: For which cauſe, unto her diſgrace and the example of all others that in Pride of their Hearts would advance themſelves above their betters, ſhe was placed in the *Heaven* with her head as it were downwards; ſo that in the revolution of the *Heavens* ſhe ſeemeth to be carried head-long.

11. PERSEUS, He hath ſix and twenty *Stars*. This was the Son of *Jupiter*, whom he in the likeneſs of a *Golden Shower* begat upon *Danae*, the Daughter of *Acriſius*. This *Perſeus* coming unto Mans Eſtate, and being furniſhed with the Sword, Hat, and Wings of his Brother *Mercury*, and the Shield of his Siſter *Minerva*, was ſent by his Foſter-Father *Polidectes*, to kill the Monſter *Meduſa*, whom he ſlew; and cutting off her Head, carried it away with him: But as he was haſting Homeward, flying in the Air, he eſpied *Andromeda* the Daughter of *Cepheus* and *Caſſiopeia* for the Pride of her Mother, bound with a Chain unto a Rock, by the Sea ſide, there to be devoured by a Whale: *Perſeus* taking notice and Pity of the caſe, undertook to fight with the Monſter, upon condition that *Andromeda* might be his Wife; to be ſhort, he delivered *Andromeda*, Married her, and returning Homeward unto the Iſle *Seriphus*, he found there his Grand-father *Acriſius*, whom by miſchance and unadviſedly he ſlew wit a Quoit: (or as *Ovid* reporteth) with the terrible ſight of the horrible Head of *Meduſa*, not knowing that it was his Grand-father: But afterwards underſtanding whom he had ſlain, he pined away through extream ſorrow: Whereupon *Jupiter* his Father pitying his Grief, took him up into *Heaven*: and there placed him in that form wherein he overcame *Meduſa* with the Sword in one Hand, and the Head of *Meduſa* in the other, and the Wings of *Mercury* at his Heels. This *Conſtellation* becauſe of the unluckineſs thereof is called by *Aſtrologers Cacodemon* (i.e.) *Unlucky*, and *Unfortunate*. For (as they ſay) they have obſerved it, that whatſoever is Born under this *Conſtellation*, having an evil Aſpect, ſhall be ſtricken with Sword, or loſe his Head. *Novidius* ſaith that it is *David* with *Goliah* his Head in one hand and his Sword in the other. The unformed *Stars* belonging unto this *Conſtellation* are three.

12. Au-

12. AURIGA, the *Waggoner*, or *Carter*: He consisteth of fourteen *Stars*: The *Arabians* call him *Alaiot*; the *Greeks Henniochus*, (*i. e*) a Man holding a Bridle in his hand, and so is he Pictured. *Eratostanes* affirmeth him to be *Erichthonius* King of *Athens*, the Son of *Vulcan*, who having most deformed Feet, devised first the use of the *Waggon* or *Chariot*, and joined Horses together to draw the same, to the end that he sitting therein, might the better conceal his Deformities. For which invention, *Jupiter*, translated him into the *Heavens*.

In this *Constellation* there are two other particular *Constellations* to be noted; whereof the one consisteth but of one *Star* alone, which is in the left Shoulder of *Auriga*, and is called *Hircus*, or *Capra* the *Goat*; the *Arabians* call it *Alhajoth*: The other consisteth of two little *Stars* a little beneath the other, standing as it were in the hand of *Auriga*; this *Constellation* is called *Hedi*, the *Kids*. The Tale is thus; *Saturn* (as you heard before) had received of the Oracle, that one of his Sons should put him out of his Kingdom, where upon he determined to devour them all: *Ops* by stealth conveyed away *Jupiter*, and sent him to *Melissus* King of *Crete*, to be Nourished. *Melissus* having two Daughters, *Amalthea* and *Melissa*, committed *Jupiter* unto their Nursery; *Amalthea* had a *Goat* that gave Suck unto two *Kids*, so that by the Milk of this *Goat*, she Nourished *Jupiter* very well. To requite this her care and courtesie, *Jupiter* after he had put his Father out of his Kingdom) translated her *Goat* and her two *Kids* into *Heaven*; and in remembrance of the Nurse, the *Goat* is called *Capra Amalthea*. *Novidius* saith, that when Christ was born, and his Birth made manifest by the Angels unto the Sheperds, one of them brought with him for a Present, a *Goat* and two young *Kids*; which in token of his good will, were placed in *Heaven*.

13. OPHIUCHUS, or SERPENTARIUS, That is, the *Serpent-bearer*. This *Constellation* hath no proper name, but is thus entituled because he holdeth a *Serpent* in his hands. It containeth four and twenty *Stars*. Some say that it is *Hercules*, and report the Tale on this manner. *Juno* being a great enemy to *Hercules*, sent two Snakes to kill him as he lay sleeping in his Cradle: but *Hercules* being a lusty Child (for *Jupiter* had spent two days in begetting him) without much ado strangled them both: In memorial of so strange an event, *Jupiter* placed him in the *Heavens*, with a *Serpent* in his hands.

14. SER-

14. SERPENS, the *Serpent* of *Ophiuchus*, which conſiſteth of eighteen *Stars*. Some ſay that it is one of the Serpents that ſhould have ſlain *Hercules* in his Cradle. *Novidius* ſaith, it is the *Viper* that bit *Paul* by the hand. Others deliver the Tale in theſe words: *Glaucus* the Son of *Minos* King of *Creta*, was by misfortune drowned in a Barrel of Honey: *Minos* his father craved the help of *Æſculapius* the Phyſician: And that he might be driven perforce to help the Child, he ſhut him up in a ſecret place, together with the dead Carcaſs: Whiles *Æſculapius* ſtood in a great maze with himſelf what were beſt to be done, upon a ſudden there came a Serpent creeping towards him; the which Serpent he ſlew with the ſtaff which he had in his hand. After this there came another Serpent in, bringing in his mouth a certain herb, which he laid upon the head of the dead Serpent, whereby he reſtored him unto Life again. *Æſculapius* uſing the ſame herb, wrought the ſame effect upon *Glaucus*. Whereupon (after that) *Æſculapius* (whom ſome affirm to be *Ophiuchus*) was placed in the *Heaven*, and the Serpent with him.

15. SAGITTA, or *Telum*; the *Arrow* or *Dart*. This was that Arrow wherewith *Hercules* ſlew the *Eagle* or *Grype* that fed upon the Liver of *Prometheus*, being tyed with chains to the top of the Mount *Caucaſus*, and in memorial of that deed, was tranſlated into *Heaven*. Others will have it to be one of thoſe Arrows which *Hercules* at his death gave unto *Philoctetes*, upon which the Deſtiny of *Troy* did depend. The whole *Conſtellation* containeth five *Stars*.

16. AQUILA, the *Eagle*, which is called *Vultur Volans*, the *Flying Grype*: It hath in it nine *Stars*. The Poetical reaſon of this *Conſtellation*, is this; *Jupiter* transforming himſelf into the form of an *Eagle* took *Ganimedes* the *Trojan Boy*, whom he greatly loved up into *Heaven*, and therefore in ſign thereof (becauſe by that means he performed his purpoſe) he placed the figure of the *Eagle* in the *Heaven*. There belong unto this *Conſtellation* ſix *Stars* (before time) unformed, but now brought into the *Conſtellation* of *Antinous*. But whereupon that name ſhould come, I know not, except it were that ſome Man deviſed it there to curry favour with the Emperour *Adrian*, who loved one *Antinous Bithynicus* ſo well, that he builded a Temple in his Honour at *Mantinea*.

17. DELPHINUS, the *Dolphin*: It containeth ten *Stars* yet;

yet *Ovid* in his Second Book *de Faſtis*, ſaith that it hath but nine. Neither did the Ancient *Aſtronomers* attribute unto it any more, according to the number of the *Muſes*; becauſe of all other Fiſhes the *Dolphin* is ſaid to be delighted with Muſick. The Tale goeth thus concerning this *Conſtellation*. When *Neptune* the God of the *Sea* greatly deſired to Match with *Amphitrite*, ſhe being very modeſt and ſhame-faced, hid her ſelf: whereupon he ſent many Meſſengers to ſeek her out, among whom the *Dolphin* by his good hap, did firſt find her; and perſwaded her alſo to match with *Neptune*: For which his good and truſty Service, *Neptune* placed him in the *Heavens*.

Others ſay, that when *Bacchus* had transformed the Mariners that would have betrayed him, into *Dolphins*, he placed one of them in *Heaven*, that it might be a Leſſon for others to take heed how they carried any one out of his Way, contrary both to his deſire, and their own promiſe. *Novidius* referreth this *Conſtellation* unto the Fiſh that ſaved *Jonas* from drowning.

18. EQUICULUS, is the *Little Horſe*, and it conſiſteth of four *Stars*. This *Conſtellation* is named almoſt of no Writer, ſaving *Ptolomeus*, and *Alphonſus* who followeth *Ptolomy*, and therefore no certain Tale or Hiſtory is delivered thereof, by what means he came into *Heaven*.

19. EQUUS ALATUS, the *Winged Horſe*, or *Pegaſus*, it containeth twenty *Stars*. This *Horſe* was bred of the blood of *Meduſa*, after that *Perſeus* had cut off her Head, and was afterwards taken and tamed by *Bellerophon*, whiles he drank of the River *Pirene* by *Corinth*, and was uſed by him in the conqueſt of *Chimera*: After which Exploit *Bellerophon*, being weary of the Earthly affairs, endeavoured to fly up into *Heaven*. But being amazed in his Flight, by looking down to the *Earth*, he fell from his *Horſe*; *Pegaſus* notwithſtanding continuing his Courſe (as they feign) entered into *Heaven*, and there obtained a Place among the other *Conſtellations*.

20. ANDROMEDA, ſhe conſiſteth of three and twenty *Stars*; but one of them is common both unto her and *Pegaſus*. This was the Daughter of *Cepheus* and *Caſſiopea*, and the Wife of *Perſeus*; the reaſon why *Minerva*, or *Jupiter* placed her in the *Heavens*, is before expreſſed. *Novidius* referreth this *Conſtellation* unto *Alexandria* the *Virgin*, whom S. *George* through the good help of his Horſe delivered from the *Dragon*.

22. TRIANGULUM, the *Triangle*, called also *Deltoton*, because it is like the fourth Letter of the Greek Alphabet Δ, which they call *Delta*; it consisteth of four *Stars*. They say it was Placed in *Heaven* by *Mercury*, that thereby the head of the *Ram* might be the better known. Others say, that it was placed there in Honour of the *Geometricians*, among whom, the *Triangle* is of no small importance. Others affirm, that *Ceres* in times past requested *Jupiter* that there might be placed in *Heaven* some Figure representing the form of *Sicily*, an *Island* greatly beloved of *Ceres*, for the Fruitfulness thereof: Now this Island being Triangular (at her request) was represented in the *Heaven* under that Form.

*Thus much concerning the* Constellations *of the* Northern Hemisphere. *Now follow the* Poetical Stories *of the* Constellation *of the* Southern Hemisphere.

## Secondly.

### *Of the* Southern Constellations.

1. CETUS, the *Whale*, It is also called the *Lyon*, or *Bear* of the *Sea*. This is that monstrous Fish that should have devoured *Andromeda*, but being overcome by *Perseus*, was afterwards translated into *Heaven* by *Jupiter*, as well for a Token of *Perseus* his Manhood, as for the Hugeness of the Fish it self. This *Constellation* consisteth of two and twenty *Stars*.

2. ORION, this hath eight and thirty *Stars*. The Poetical reason of his translation into the *Heavens*, shall be shewn in the *Scorpion*, amongst the *Zodiacal Constellations*. The Ancient *Romans* called this *Constellation Fugata*, because it is most pestiferous unto Cattel, and as it were the very Cut-throat of them. There are bright *Stars* in his *Girdle*, which we commonly call our *Ladies yard*, or *Wand*. *Novidius*, applying this Sword of *Orion* unto Scripture, will have it to be the Sword of *Saul* afterwards called *Paul*, wherewith he persecuted the Members of Christ: Which after his Conversion was placed in *Heaven*. In his *Left Shoulder* there is a very Bright *Star*, which in *Latine* is called *Bellatrix* the *Warriour*, in the Feminine gender. I cannot find the reason except it be this; that Women born under this

this *Conſtellation* ſhall have mighty Tongues: The reaſon of the *Ox-hide* which he hath in his Hand may be gathered out of the next Story.

3. FLUVIUS, the *River*; it comprehendeth thirty four *Stars*. It is called by ſome *Eridanus*, or *Padus*; and they ſay that it was placed in *Heaven* in Remembrance of *Phaeton*, who having ſet the whole World on Fire by reaſon of miſguiding of his Father *Phebus* his Chariot, was ſlain by *Jupiter* with a Thunderbolt, and tumbling down from *Heaven*, fell into the River *Eridanus*, or *Padus* which the *Italians* call *Po*. Others ſay that it is *Nylus*, and that that Figure was placed in *Heaven* becauſe of the Excellency of that River, which by the Divines is called *Gihon*; and is one of the *Rivers* of *Paradice*. Others call it *Flumen Orionis* the Flood of *Orion*, and ſay that it was placed there, to betoken the Off-ſpring from whence *Orion* came: For the Tale is thus reported of him.

*Jupiter*, *Neptune*, and *Mercury*, travelling upon the Earth in the likeneſs of Men, were requeſted by *Hyreus* to take a Poor Lodging at his Houſe for a Night: They being overtaken with the Evening, yielded unto his requeſt; *Hyreus* made them good Cheer; killing an *Ox* for their better Entertainment: The Gods ſeeing the good heart of the Old Man, willed him to demand what he would in recompence of his ſo friendly Cheer. *Hyreus* and his Wife being old, requeſted the Gods to gratifie them with a Son. They to fulfil his deſire, called for the Hide of the *Ox* that was ſlain, and having received it, they put it into the *Earth*, and made water into it all three together, and covering it, willed *Hyreus* within ten Months after to dig it out of the *Earth* again, which he did, and found therein a Man child, whom he called *Ourion*, *ab Urina*, of Piſs; altho' afterwards by leaving out the ſecond Letter, he was named *Orion*. At ſuch time therefore as he was Placed in *Heaven*, this *Flood* was joined hard to his heels, and the *Ox-hide* wherein the Gods did Piſs, was ſet on his left Hand, in memorial of his Off-ſpring.

4. LEPUS, the *Hare*, which conſiſteth of twelve *Stars*. This *Conſtellation* was placed in *Heaven* between the Legs of *Orion*, to ſignifie the great delight in Hunting which he had in his Life time: But others think it was a frivolous thing, to ſay that ſo notable a Fellow as *Orion* would trouble himſelf with ſo ſmall and timorous a Beaſt as the *Hare*: And therefore they tell the Tale thus.

In times past there was not a *Hare* left in the Isle *Leros*: A certain Youth therefore of that Island, being very desirous of that kind of Beast, brought with him from another Country thereabout, an *Hare* great with Young; which when she had brought forth, they in time became so acceptable unto the other Country-men, that every one almost desired to have and keep a *Hare*, By reason whereof, the number of them grew to be so great, within a short space after, that the whole Island became full of Hares, so that their Masters were not able to find them Meat: Where upon the Hares breaking forth into the Fields, devoured their Corn. Wherefore the Inhabitants being bitten with hunger, joined together with one consent, and (and tho' with much a do) destroyed the Hares. *Jupiter* therefore Placed this *Constellation* in the *Heavens*; as well to express the exceeding fearfulness of the Beast, as also to teach Men this lesson; that there is nothing so much to be desired in this Life, but that at one time or another it bringeth with it more grief than pleasure. Some say, that it was placed in *Heaven* at the request of *Ganimedes*, who was greatly delighted with hunting the Hare.

5. CANIS MAJOR, the *Great Dog*, it consisteth of eighteen *Stars*. It is called *Syrius Canis*, because he causeth a mighty Drought by reason of his Heat. This is the *Constellation* that giveth the name unto the *Canicular* or *Dog Days*; whose beginning and end is not alike in all Places, but hath a difference according to the Country and Time: As in the time of *Hippocrates* the Physitian, who lived before the Time of Christ 400 Years, the *Canicular Days* began the 13, or 14 of *July*. In the Time of *Avicenna*, the *Spaniard*, who lived in the Year of our Lord 1100: the *Canicular Days* began the 15, 16, or 17. of *July*. In our Country, they being about St. *James-tide*, but we use to account them from the 6 of *July*, to the 17 of *August*; which is the time when the *Sun* beginneth to come near unto, and to depart from this *Constellation*.

*Novidius* will have it to be referred to *Tobias* Dog; which may very well be, because he hath a Tail, *Tobias* Dog had one, as a certain fellow once concluded: Because it is written that *Tobias* his Dog fawned upon his Master, therefore it is to be noted (said he) that he had a Tail. The Poets say, that this is the Dog whom *Jupiter* set to keep *Europa*, after that he had stolen her away, and conveyed her into *Crete*, and for his good service

was

was placed in *Heaven*. Others ſay, that it was one of *Orion* his Dogs. There belong unto this *Conſtellation* 11 *Stars* unformed.

6. CANIS MINOR, the *Leſſer Dog*; this of the *Greeks* is called *Procyon*, of the *Latins Ante Canis*; it containeth but two *Stars*. Some ſay, that this was alſo one of *Orions* Dogs. Others rather affirm it to be *Mera* the Dog of *Origone*, or rather of *Icarius* her Father, of whom mention is made in the *Conſtellation* of *Bootes*, and *Virgo*. This Dog of meer love to his Maſter, being ſlain, as aforeſaid, threw himſelf into the River *Anigrus*, but was afterward tranſlated into *Heaven*, with *Origone*. Among the Poets there is great diſſention which of the two ſhould be the Dog of *Origone*; ſome ſaying one, and ſome the other, and therefore they do many times take the one for the other.

7. ARGO NAVIS, the *Ship Argo*, which comprehendeth one and forty *Stars*; this is the *Ship* wherein *Jaſon* did fetch the Golden Fleece from *Colchis*, which was afterward placed in *Heaven* as a Memorial, not only becauſe of the great Voyage, but alſo, becauſe (as ſome will have it) it was the firſt *Ship* wherein any Man Sailed. Their reaſon why this *Ship* is not made whole is, that thereby Men might be put in mind not to deſpair, albeit that their *Ship* miſcarry in ſome part now and then. Some avouch it to be the *Ark* of *Noah*. *Novidius* ſaith, it is the *Ship* wherein the *Apoſtles* were, when *Chriſt* appeared unto them Walking on the *Sea*. In one of the *Oars* of this *Ship*, there is a great *Star*, called *Canopus*, or *Canobus*, which the *Arabians* called *Shuel*, as it were a Bon-fire, becauſe of the greatneſs thereof. It is not ſeen in *Italy*, nor in any Country on this ſide of *Italy*: Some ſay that *Canobus* the Maſter of *Menelaus* his *Ship* was transformed into this *Star*.

8. HYDRA, the *Hydre*; that hath five and Twenty *Stars*, and two unformed.

9. CRATER, the *Cup* or *Standing piece*; that hath ſeven *Stars*, ſome ſay that this was the *Cup* wherein *Tagathon*, that is the chief God, mingled the ſtuff whereof he made the Souls of Men.

10. CORVUS, the *Crow*; this hath ſeven *Stars*. Theſe three *Conſtellations* are to be joined together, becauſe they depend upon one Hiſtory, which is this. On a time *Apollo* made a ſolemn Feaſt to *Jupiter*, and wanting water to ſerve his turn, he delivered a *Cup* to the *Crow* (the Bird wherein he chiefly delighted) and

ſent

ſent him to fetch Water therein. The *Crow* flying towards the *River*, eſpied a Fig-tree, fell in hand with the Figs, and abode there till they were Ripe: In the end, when he had fed his fill of them, and had ſatisfied his Longing, he bethought himſelf of his Errand, and by reaſon of his long delay, fearing a check, he caught up a *Snake* in his Bill, brought it to *Apollo*, and told him that the *Snake* would not let him fill the *Cup* with Water. *Apollo* ſeeing the impudence of the Bird, gave him this gift, that as long as the Figs were not ripe upon the Tree, ſo long he ſhould never Drink: And for a memorial of the ſilly excuſe that he made, he placed both the *Crow*, *Cup*, and *Snake* in *Heaven*.

11. CENTAURUS, the *Centaur*, which comprehendeth ſeven and thirty *Stars*. Some ſay that this is *Typhon*, others call him *Chiron*, the Schoolmaſter of thoſe three excellent Men, *Hercules*, *Achilles*, and *Eſculapius*; unto *Hercules* he read *Aſtronomy*, he trained up *Achilles* in *Muſick*, and *Eſculapius* in *Phyſick*: And for his upright Life he was turned into this *Conſtellation*. Yet *Virgil* calleth *Sagittarius* by the name of *Chiron*. In the *hinder Feet* of this *Conſtellation*, thoſe *Stars* are ſet which are called the *Croſiers*, appearing to the *Mariners* as they Sail towards the *South Sea*, in the form of a *Croſs*, whereupon they have their name. The four *Stars* which are in the *Garniſh* of the *Centaurs Spear*, are accounted by *Proclus* as a peculiar *Conſtellation*, and are called by him *Thyrſilochus*, which was a *Spear* compaſſed about with Vine Leaves: But they are called by *Copernicus* and *Clavius*, and other *Aſtronomers*, the *Stars* of his *Target*. It ſhould ſeem that they were deceived by the old Tranſlation of *Ptolomy*, wherein *Scutum* is put for *Haſta* (*i.e.*) the *Target*, for the *Spear*, as it is well noted by our Country-man M. *R. Record*, in his Book Intituled, *The Caſtle of Knowledge*.

12. LUPUS, the *Wolf*, or the Beaſt which the *Centaur* holdeth in his Hand, containeth nineteen *Stars*, the Poetical reaſon is this, *Chiron* the *Centaur* being a juſt Man, was greatly given to the Worſhip of the Gods: For which thing, that it might be notified to all Poſterity, they placed him by this Beaſt, which he ſeemeth to ſtick and thruſt through with his *Spear* (as it were) ready to kill for Sacrifice.

13. ARA, the *Altar*, it is alſo called *Lar*, or *Thuribulum*, (*i.e.*) a Chimney with the Fire, or a Cenſor. It conſiſteth of ſeven *Stars*, and is affirmed of ſome Poets, to be the *Altar* where-

on

on the *Centaur* was wont to offer up his Sacrifice. But others tell the Tale thus. When as the great Gyants, called the *Tytans*, laboured as much as might be to pull *Jupiter* out of *Heaven*, the Gods thought it good to lay their heads together, to adviſe what was beſt to be done: Their concluſion was, that they ſhould all with one conſent join hands together to keep out ſuch fellows; and that this their League might be confirmed, and throughly ratified, they cauſed the *Cyclops* (which were Workmen of *Vulcan*) to make them an *Altar*: About this *Altar* all the Gods aſſembled, and there ſwore, that with one conſent they would withſtand their Enemies; afterwards, having gotten the Victory, it pleaſed them to place this *Altar* in *Heaven*, as a Memorial of their League, and a token of that good which unity doth breed.

14. CORONA AUSTRINA, the *South Garland*, it hath 13 *Stars*. Some ſay that it is ſome trifling *Garland* which *Sagittarius* was wont to wear, but he caſt it away from him in jeſt, and therefore it was placed between his Legs: Others call it the Wheel of *Ixion*, whereupon he was Tormented for that great diſcourteſie he would have offered unto *Juno*, thinking indeed to have gotten up her Belly: But *Jupiter* ſeeing the impudency of the Man, tumbled him out of *Heaven* (where by the Licence of the Gods, he was ſome time admitted as a gueſt) into *Hell*, there to be continually Tormented upon a *Wheel*. The Figure of which *Wheel* was afterwards placed in *Heaven*, to teach Men to take heed how they be too ſaucie to make ſuch courteous proffers unto other Mens Wives. The *Greeks* call this *Conſtellation* by the name of *Uraniſcus*, becauſe of the Figure thereof: For it repreſenteth the Palate or Roof of the mouth, which they call *Uraniſcus*.

15. The laſt is PISCIS AUSTRINUS, or *Notius*, the *South Fiſh*, which comprehendeth eleven *Stars*, beſides that which is in the Mouth thereof, belonging to the *Water*, which runneth from *Aquarius*, and is called by the *Arabians Fomahant*. The reaſon why this *Fiſh* was placed in the *Heaven*, is uncertain: Yet ſome affirm, that the Daughter of *Venus* going into a Water to Waſh her ſelf, was ſuddenly transformed into a *Fiſh*, the which *Fiſh* was afterwards tranſlated into *Heaven*. The unformed *Stars* belonging unto this *Conſtellation* are ſix.

*Thus much concerning the* Conſtellation *of the* Northern *and* Southern Hemiſpheres; *now follow the* Poetical Stories *of the* Zodiatical *Conſtellations*. Thirdly.

## Thirdly.

### *Of the* Zodaical Conſtellations.

1. ARIES, the *Ram*, is called by the *Greeks Crios*; it containeth in it thirteen *Stars*, which were brought unto this *Conſtellation* by *Thyeſtes*, the Son of *Pelops*, and Brother of *Acreus*. This is the *Ram* upon which *Prixus* and *Helle* his Siſter, the Children of *Athamas* did ſit, when they fled from their Stepmother *Ino*, over the *Sea* of *Helleſpont*: Which *Ram* was afterwards for his good Service, tranſlated into *Heaven* by *Jupiter*. Others ſay that it was that *Ram* which brought *Bacchus* unto the Spring of *Water*, when through Drought he was likely to have Periſhed in the Deſert of *Lybia*. *Novidius* will have this to be the *Ram* which *Abraham* Offered up inſtead of his Son *Iſaac*. The *Star* that is firſt in the Head of the *Ram*, is that from whence our later *Aſtronomers* do account the *Longitude* of all the reſt, and it is diſtant from the Head of *Aries*, in the tenth *Sphere*, 27 Degrees 53 Minutes. The unformed *Stars* belonging unto this *Conſtellation*, are five.

2. TAURUS, the *Bull*, which conſiſteth of twenty three *Stars*. This was tranſlated into *Heaven*, in Memorial of the Rape committed by *Jupiter* on *Europa* the Daughter of *Agenor*, King of *Sidon*; whom *Jupiter* in the likeneſs of a White *Bull* ſtole away, and tranſported into *Candia*. Others ſay, that it was *Io* the Daughter of *Inachus*: Whom *Jupiter* loved, and turned into the form of a *Cow*, to the intent that *Juno* coming at unwares, ſhould not perceive what part he had played: *Jupiter* afterward in memorial of that crafty conveyance, placed that Figure in *Heaven*; The reaſon why the Poets name not certainly whether it be a *Cow* or a *Bull*, is becauſe it wanteth the hinder Parts; yet of the moſt of them it is called a *Bull*. In the Neck of the *Bull* there are certain *Stars*, ſtanding together in a Cluſter, which are commonly called the *Seven Stars*: Although there can hardly be diſcerned any more than ſix. Theſe are reported to be the ſeven Daughters of *Atlas*, called *Atlantiades*, whereof ſix had company with the Immortal Gods, but the ſeventh (whoſe name was *Merope*) being married unto *Syſiphus* a Mortal Man, did there-

therefore withdraw and hide her Self, as being aſhamed that ſhe was not ſo fortunate in matching herſelf as her Siſters were. Some ſay, that that *Star* which is wanting is *Electra*, the eldeſt Daughter of *Atlas*, and that therefore it is ſo dim, becauſe ſhe could not abide to behold the deſtruction of *Troy*; but at that time and ever ſince, ſhe hid her face. The reaſon why they were taken up into *Heaven*, was, their great pity towards their Father, whoſe miſhap they bewailed with continual Tears. Others ſay, that whereas they had vowed perpetual Virginity, and were in danger to loſe it, by reaſon of *Orion*, who greatly aſſailed them, being overtaken with their Love; they requeſted *Jupiter* to ſtand their Friend, who tranſlated them into *Stars*, and placed them in that part of *Heaven*. The Poets call them *Pleiades*, becauſe when they riſe with the *Sun*, the Mariners may commit themſelves to the *Sea*. Others will have them to be ſo termed *a Pluendo*; becauſe they procure Rain. Others give them this Name, of the *Greek* word *Cleiones*, becauſe they be many in number. They be alſo called *Vigilia*, becauſe they riſe with the *Sun* in the *Spring time*: Likewiſe *Athoraia*, becauſe they ſtand ſo thick together. Our Men call them by the Name of the *Seven Stars*, or *Brood Hen*. The *Aſtronomers* note this as a ſpecial thing concerning theſe *Stars*, that when the *Moon* and theſe *Stars* do meet together, the eyes are not to be medled withal, or cured if they be ſore: their reaſon is, becauſe they be of the Nature of *Mars* and the *Moon*.

Moreover, there be five *Stars* in the *Face* of the *Bull*, repreſenting the form of the *Roman* Letter V, whereof one (which is the greateſt) is called the *Bull's Eye*. They be called *Hyades*, and were alſo the Daughters of *Atlas*, who ſo long bewailed the death of *Hyas* their Brother, ſlain by a *Lyon*, that they died for ſorrow, and were afterwards placed in *Heaven*, for a Memorial of that great Love they bore to their Brother. The Ancient *Romans* call the *Bull's Eye Parilicium*, or *Palelicium*, of *Pales* their Goddeſs; whoſe Feaſt they Celebrated after the Conjunction of this *Star* and the *Sun*. The unformed *Stars* belonging unto this *Conſtellation*, are eleven.

3. GEMINI, the *Twins*; It conſiſteth of eighteen *Stars*. The Poets ſay, they are *Caſtor* and *Pollux*, the Sons of *Leda*, brethren moſt loving, whom therefore *Jupiter* tranſlated into *Heaven*. Some ſay that the one of them is *Apollo*, and the other *Hercu-*

*les*: but the moſt affirm the former. The unformed *Stars* of this *Conſtellation* are ſeven, whereof one is called *Tropus*, becauſe it is placed next before the *Foot* of *Caſtor*.

4. CANCER, the *Crab*, it hath nine *Stars*. This is that *Crab* which bit *Hercules* by the Heel as he fought with the Serpent *Hydra* in the Fen *Lerna*, and for his forward Service, was placed in Heaven by *Juno*, the utter Enemy of *Hercules*. In this *Conſtellation* there are *Stars* much ſpoken of by the Poets, although they be but ſmall; whereof one is called the *Crib*, other two are the two *Aſſes*, whereof one was the *Aſs* of *Bacchus*, the other of *Vulcan*, whereon they rode to Battel, when as the Gyants made War with the Gods; with whoſe Braying and ſtrange Noiſe, the Gyants were ſo ſcared upon the ſudden, that they forſook the Field, and Fled. The Gods getting the Victory, in triumphing manner tranſlated both the *Aſſes*, and their *Manger* into *Heaven*. The unformed *Stars* of this *Conſtellation* are four. It is called *Animal Retrogradum*, for when the *Sun* cometh into this *Sign*, he maketh *Retrogradation*.

5. LEO, the *Lyon*; it hath 27 *Stars*, this is that *Lyon* which *Hercules* overcame in the Wood of *Nemea* and was placed in *Heaven* in remembrance of ſo notable a Deed. *Ovidius* ſaith, this was one of the *Lyons* which were in the Den into which *Daniel* was caſt, and was therefore placed in Heaven, becauſe of all other he was moſt friendly unto *Daniel*. In the *Breſt* of this *Conſtellation* is that notable great *Star*, the light whereof is ſuch, as that therefore it is called by *Aſtronomers Bazileus* or *Regulus* (*i.e.*) the *Viceroy*, or little King among the reſt. The unformed *Stars* belonging to the *Lyon* are eight; whereof three make the *Conſtellation* which is now called *Coma Berenices*, that is, the hair of *Berenice*. This *Conſtellation* was firſt found out and invented by *Canon* the *Mathematitian*, but deſcribed by *Calimachus* the Poet. The occaſion of the ſtory was this. *Ptolomeus Eurgetes* having married his Siſter *Berenice*, was ſhortly after enforced to depart from her, by reaſon of the Wars he had begun in *Aſia*: Whereupon *Berenice* made this Vow, that if he returned home again in ſafety, ſhe would offer up her hair in *Venus* Temple. *Ptolomy* returned ſafe; and *Berenice*, according to her Vow, cut off her hair and hung it up. After certain days, the hair was not to be found; whereupon *Ptolomy* the King was greatly diſpleaſed: But *Canon*, to pleaſe the humor of the King, and to

curry

curry favour with him, perſwaded him that *Venus* had conveyed the Hair into *Heaven*. *Canon* attributeth ſeven *Stars* unto it, but *Ptolomy* alotteth it but three, becauſe the other be inviſible.

6. VIRGO, the *Virgin*, it hath twenty ſix *Stars*. This is aſſumed to be Juſtice, which among all the Gods ſometime living upon the *Earth*, did laſt of all forſake the ſame, becauſe of the Wickedneſs that began to multiply therein, and chooſe this Place for her Seat in Heaven.

Others ſay, that it was *Aſtræa*, the Daghter of *Aſtræus*, one of the Gyants that were called *Titans*, who fighting againſt the Gods, *Aſtræa* took their parts againſt her own Father, and was therefore after her death commended unto the Heavens, and made one of the Twelve *Signs*.

Others ſay, that it was *Erigone*, the Daughter of *Icarius*, who for that her Father was ſlain by certain Drunken men, for very Grief thereof hanged her ſelf: But *Jupiter* taking pity of the *Virgin* for her natural affection, traſlated her into Heaven.

In her *Right Wing* there is one *Star* of ſpecial note, which by the *Aſtronomers* is called *Vindemiator* (*i.e.*) the gatherer of Grapes. This was *Ampelos* the Son of a Satyr and a Nymph, and greatly beloved of *Bacchus*, unto whom in token of his love *Bacchus* gave a ſingular fair Vine, planted at the Foot of an Elm (as the manner was in old time.) But *Ampelos* in Harveſt gathering Grapes, and taking little heed to his footing, fell down out of the Vine, and brake his neck. *Bacchus*, in Memorial of his former affection, tranſlated him into Heaven, and made him one of the principal *Stars* in this *Conſtellation*. There is another great *Star* in the hand of the *Virgin*, called of the *Latins Spica*, of the *Greeks Stachus*, of the *Arabians Azimech* (*i.e.*) the *Ear of Corn*: Whereby they ſignifie, that when the *Sun* cometh to this *Sign*, the Corn waxeth Ripe. *Albumazer* the *Arabian*, and *Novidius*, take this *Conſtellation* for the Virgin *Mary*. The unformed *Stars* in this *Conſtellation* are ſix.

7. LIBRA, the *Ballance*, it containeth 8 *Stars*; *Cicero* calleth it *Jugum* the *Yoak*, and here it is to be noted, that the ancient *Aſtronomers* that firſt ſet down the number of the *Conſtellations* contained in the *Zodiack*, did account but eleven therein, ſo that the *Sign* which now is called *Libra*, was heretofore called *Chelæ*, that is to ſay, the *Claws of the Scorpion*, which poſſeſſeth the ſpace of two whole *Signs*. But the later *Aſtronomers*, being deſirous

ſirous to have Twelve *Signs* in the *Zodiack*, called thoſe eight whereof the *Claws of the Scorpion* do conſiſt, by the Name of *Libra*, not that there was any Poetical Fiction to induce them thereto, but only moved by this reaſon, becauſe the *Sun* joyning with this *Conſtellation*, the Day and the Night are of an equal Length, and are (as it were) equally Poized in a pair of *Ballance*. Yet (as I remember) ſome will have this to be the *Ballance* wherein Juſtice, called alſo *Aſtraa* weighed the Deeds of Mortal Men, and therein preſented them unto *Jupiter*. It hath nine unformed *Stars* appertaining unto it.

8. SCORPIO, the *Scorpion*; called of the *Arabians*, *Alatrab*; of *Cicero*, *Nepa*. It conſiſteth of twenty one *Stars*. The Fiction is thus; *Orion* the Son of *Hyreus* greatly beloved of *Diana*, was wont to make his boaſt, that he was able to overcome what Beaſt ſoever was bred upon the *Earth*: The *Earth* being moved with this ſpeech brought forth the *Scorpion*, whereby *Orion* was ſtung to death. *Jupiter* thereupon at the requeſt of the *Earth* tranſlated both the *Scorpion* and *Orion* into *Heaven*; to make it a Leſſon for ever, for Mortal Men not to truſt too much unto their own Strength: And to the end he might ſignifie the great enmity between them, he placed them ſo in the *Heaven*, that whenſoever the one Riſeth, the other ſetteth; and they are never both of them ſeen together above the *Horizon* at once: *Guliel mus Poſtellus* will have it to be the *Serpent* which beguiled *Eve* in *Paradiſe*. The unformed *Stars* about this *Scorpion* are three.

9. SAGITARIUS, the *Archer*. It hath 31 *Stars*. Touching this *Sign*, there are among the Poets many and ſundry Opinions. Some ſay that it is *Crocus*, the Son of *Pupheue*, that was nurſe unto the Muſes. This *Crocus* was ſo forward in Learning of the Liberal Sciences, and in the practice of Feats of Activity, that the Muſes entreated *Jupiter* that he might have a place in *Heaven*. To whoſe requeſt *Jupiter* inclining, made him one of the 12 *Signs*: And to the end that he might expreſs the excellent qualities of the Man, he made his hinder parts like unto a Horſe, thereby to ſignifie his ſingular knowledge in Horſemanſhip: And by his *Bow* and *Arrow*, he declared the ſharpneſs of his Wit. Whereupon the *Aſtrologers* have this conceit, that he that is born under *Sagitarius*, ſhall attain to the knowledg of many Arts, and be of prompt Wit, and great Courage. *Virgil* affirmeth this to be *Chiron* the *Centaur*, who for his ſingular Learning and Juſtice

was

was made the Maſter of *Achilles*. At which time *Hercules* coming to viſit him (for he had heard both of the worthineſs of the School-Maſter, and of the great hopes of the Scholar) brought with him his Quiver of Arrows dipped in the Blood of the Serpent *Hydra*, but *Chiron* being deſirous to ſee his ſhafts, and not taking heed of them being in his hand, let one of them fall upon his foot, and being greatly tormented, not only by the anguiſh of the poyſon working in the Wound, but much more becauſe he knew himſelf to be Immortal, and his wound not to be recovered by Medicine, he was enforced to make requeſt unto the Gods, that he might be taken out of the *World*, who pitying his caſe, took him up into *Heaven* and made him one of the Twelve *Signs*.

10. CAPRICORNUS, the *Goat*, It conſiſteth of 28 *Stars*. The Poets ſay that this was *Pan*, the God of the Shepherds, of whom they feign in this manner: The Gods having War with the *Gyants*, gathered themſelves together into *Egypt*, *Typhon* the *Gyant* purſued them thither, whereby the Gods were brought into a Quandary, that well was he that by changing his ſhape might ſhift for himſelf. *Jupiter* turned himſelf into a *Ram*: *Apollo* became a *Crow*: *Bachus* a *Goat*: *Diana* lurked under the form of a *Cat*: *Juno* transformed her ſelf into a *Cow*: *Venus* into a *Fiſh*: *Pan* leaping into the River *Nilus*, turneth the upper part of his body into a *Goat*, and the lower part into a *Fiſh*. *Jupiter* wondring at this ſtrange device, would needs have that Image and Picture tranſlated into *Heaven*, and made one of the Twelve *Signs*. In that the hinder part of this *Sign* is like a *Fiſh*, it betokeneth that the latter part of the month wherein the *Sun* poſſeſſeth this *Sign*, enclineth unto Rain.

11. AQUARIUS, the *Waterman*: It hath 42 *Stars*, whereof ſome make the figure of the *Man*: Other ſome the *Water-pot*; & ſome the *Stream* of *Water* that runneth out of the *Pot*. This is feigned to be *Ganimedes* the *Trojan*, the ſon of *Oros* and *Callirhoe*, whom *Jupiter* did greatly Love for his excellent favour and Beauty, and by the ſervice of his Eagle carried him up into *Heaven*, where he made him his Cup-bearer, and called him *Aquarius*. Others notwithſtanding think it to be *Deucalion* the ſon of *Prometheus* whom the Gods tranſlated into *Heaven*, in Remembrance of that mighty Deluge which hapned in his time, whereby Mankind was almoſt utterly taken away from the Face of the *Earth*. The unformed *Stars* belonging unto this *Sign* are three.

12. PIS-

12. PISCES, the *Fishes*: These together with the *Line* that knitteth them together, contain twenty four *Stars*. The Poets say, that *Venus* and *Cupid* her Son coming upon a certain time unto the River *Euphrates*, and sitting upon the Bank thereof, upon a sudden espied *Typhon* the *Gyant*, that mighty and fearful Enemy of the Gods coming towards them; Upon whose Sight, they being stricken with exceeding fear, leapt into the River, where they were received by two *Fishes*, and by them saved from drowning. *Venus* for this good turn, transl ted them into *Heaven*. *Gulielmus Postellus* would have them to be the *Two Fishes* wherewith Christ fed the 5000 Men. The unformed *Stars* of this *Constellation* are four.

Thus have I briefly run over the Poetical reasons of the *Constellations*: It remains now that I speak of the *Milky way*.

VIA LACTEA, or *Circulus Lacteus*, by the *Latins* so called; and by the *Greeks Galaxia*; and by the *English*, the *Milky way*. It is a broad White Circle that is seen in the *Heaven*: In the *North Hemisphere*, it beginneth at *Cancer*, on each side the Head thereof, and passeth by *Auriga*, by *Perseus*, and *Cassiopeia*; the *Swan*, and the Head of *Capricorn*, the Tail of *Scorpio*, and Feet of *Centaur*, *Argo* the *Ship*, and so unto the Head of *Cancer*. Some in a sporting manner do call it *Watling street*, but why they do call it so, I cannot tell; except it be in regard of the narrowness that it seemeth to have; or else in respect of that great High Way that lyeth between *Dover* and S. *Albans*, which is called by our Men, *Watling-street*.

*Ovid* saith, that it is the great Causey, and the High-way that leadeth unto the place of *Jupiter*; but he alledgeth not the cause of the Whiteness: belike he would have us imagine that it is made of White Marble.

Others therefore alledge these causes: *Jupiter* having begotten *Mercury* of *Maia* the Daughter of *Atlas*, brought the Child when he was born, to the Breast of *Juno* lying asleep: But *Juno* awaking threw the Child out of her Lap, and let the Milk run out of her Breast in such abundance that (spreading it self about the *Heaven*) it made that Circle which we see. Others say, that it was not *Mercury*, but *Hercules*; and that *Juno* did not let the Milk run out of her Breast, but that *Hercules* suckt them so earnestly, that his Mouth run over, and so this Circle was made.

Others say, that *Saturn* being desirous to devour his Children,

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his Wife *Ops* preſented him with a Stone wrapped in a Clout, inſtead of his Child: This Stone ſtuck ſo faſt in *Saturn* his Throat as he would have ſwallowed it, that without doubt he had therewithall been Choaked, had he not been relieved by his Wife, who by preſſing the Milk out of her Breaſts ſaved his Life: The Milk that miſſed his Mouth (whereof you muſt ſuppoſe ſome ſufficient quantity) fell on the *Heavens*, and running along made this Circle.

Dr. *Hood Commenting upon Conſtellations*, *ſaith*; The *Stars* are brought into *Conſtellations*, for Inſtruction ſake, Things cannot be taught without Names: To give a Name to every *Star* had been troubleſome to the Maſter, and for the Scholar; for the Maſter to Deviſe, and for the Scholar to Remember: And therefore the *Aſtronomers* have reduced many *Stars* into one *Conſtellation*; that thereby they might tell the better where to ſeek them; and being ſought, how to expreſs them. Now the *Aſtronomers* did bring them into theſe Figures, and not into other, being moved thereto by theſe three Reaſons.

Firſt, theſe Figures expreſs ſome properties of the *Stars* that are in them; as thoſe of the *Ram* to be Hot and Dry; *Andromeda* Chained betokeneth Impriſonment, the Head of *Meduſa* Cut off, ſignifieth the loſs of that part: *Orion* with his terrible and threatning geſture, importeth Tempeſt and terrible Effects. The *Serpent*, the *Scorpion* and the *Dragon*, ſignifie Poyſon: The *Bull* inſinuateth a Melancholy Paſſion: The *Bear* inferreth Cruelty, *&c.*

Secondly, the *Stars* (if not preciſely, yet after a ſort) do repreſent ſuch a Figure, and therefore that Figure was aſſigned them: As for Example, the *Crown*, both *North* and *South*, the *Scorpion*, and the *Triangle*, Repreſent the Figures which they have.

The third cauſe was, the continuance of the Memory of ſome notable Men, who either in regard of their ſingular Pains taken in *Aſtronomy*, or in regard of ſome other notable Deed, had well deſerved of Mankind.

The firſt Author of every particular *Conſtellation* is uncertain; yet are they of great Antiquity; we receive them from *Ptolomy*, and he followed the *Platonicks*; ſo that their Antiquity is great. Morover, we may perceive them to be Ancient by the Scriptures, and by the Poets. In the 38 Chapter of *Job* there

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is mention made of the *Pleiades*, *Orion*, and *Arcturus*, and *Mazzaroth*, which some interpret the Twelve *Signs*: *Job* lived in the time of *Abraham*, as *Syderocrates* maketh mention in his Book *de Commensurandis Locorum Distantiis*.

Now besides all this, Touching the reason of the Invention of these *Constellations*, the Poets in seting forth those Stories, had this purpose, to make them fall in Love with *Astronomy*: When *Demosthenes* could not get the People of *Athens* to hear him in a matter of great Moment, and Profitable for the Commonwealth, he began to tell them a Tale of a Fellow that sold an Ass; by the which Tale he so wrought on the *Athenians*, that they were both willing to hear his whole Oration, and to put in Practice that whereunto he exhorted them. The like intent had the Poets in these Stories: They saw that *Astronomy* being for Commodity singular in the Life of Man, was almost of all men utterly neglected: Hereupon they began to set forth that Art under these Fictions: that thereby such as could not be perswaded by commodity, might by the Pleasure be induced to take a View of these matters, and thereby at length fall in Love with them. For commonly note this, that he that is ready to Read the Stories, cannot content himself therewith, but desireth also to know the *Constellations*, or at leastwise some Principal *Star* therein.

FINIS.

A

# DISCOURSE

Of the

## *Antiquity, Progress* and *Augmentation*

Of

# ASTRONOMY.

FIRST it seems not to be doubted, but that there was some kind of Observation of Bodies *Cœlestial*; as soon as there were Men: considering that the Spectacle which the *Heavens* constantly present, is both so Glorious, and so Useful, that Men could not have Eyes to see, and not fix them Attentively and Considerately thereupon. For, among other Appearances, when they saw the *Sun* daily to change the Places of its Rising and Setting, at certain Times of the Year to approach nearer to the *Earth* in its Diurnal Arch, and at others again to mount up to a Height much more sublime and remote from it; and that his coming nearer to the *Earth* made *Winter*, and his remove Higher made *Summer*: we say, when they Beheld these things, doubtless they could not but seriously remark and consider this vicissitude, according to which they might expect the Season would be more Hard, or Mild, to them in this lower Region of the World. Again, so admirably Various did the Moon appear, in her several Shapes and Dresses of Light, that she could not but invite Mens Eyes, and engage them to frequent Speculations: especially when She assumed those various Faces or appearances, at set and certain Times, in respect whereof it came to pass, that every Nation Measured their Times and Seasons, by those her constant and Periodical Circuits; & this, because those Periods succeeded much more frequently than the Erections and Depressions of the

Artic. 1. *Observations Cœlestial, from the beginning of the World; though rude and inartificial.*

*Sun*. To these, we may add that beautiful shew of the Nightly *Stars*, undergoing likewise their Variations, according to the variety of Seasons, & more particularly that bright *Star* of *Lucifer*, Rising sometimes Later, sometimes Earlier, and sometimes not at all, before the *Sun*, and the like. But, what we shall principally note, is only this; that though Mankind was Long, before they came to make enquiries into the causes of these *Cœlestial* Changes and variations, restrained to set Periods: yet they Observed them from the very First Age, and not only Admired, but also accommodated what they Observed, to the Uses of their Lives and their Successours. Here it might not be fruitless, to remember that *Prometheus*, who was imagined to have framed the First Man, was also imagined to have given him an erected Figure, and sublime Countenance; to the end he might the more advantageously advance his Eyes to the *Heavens*, and contemplate the Glory and Motions of the *Cœlestial* Lights. But because this is too General, and rude a way of Observation; and it is our business to look back into those Times *wherein Men first made such Observations of Syderal Bodies, as gave them the hint and occasion of reducing them to Method, and founding the Principles of the Art, or Science of Astronomy, thereupon*: we must have recourse to the monuments in *Sacred Writ*, for the understanding of that obscure matter.

Articl. II. *Sacred records examined, and* Moses *found to be the First* Astronomer *there spoken of. lib.* 1. *Ant. c.* 3.

And indeed, the Light we expect from *Sacred Leaves*, would soon be clear enough to discuss all the Darkness, wherein the Original of *Astronomy* seems involved; could we but from them deduce the least evidence for that which the learned Antiquary among the Jews, *Josephus* affirms of the Sons of *Seth*; *viz. that they invented the Science of the Heavens, before the Flood, and engraved the same on two Pillars, the one of Brick, the other of Stone, that so it might be preserved in the one, in case the Fury of the Deluge to come, should demolish and deface the other*: or if there remained to us any the most slender Testimony of the Reason he there gives, of the so great Longevity of Men in those Days; namely, that the duration of their Lives was sufficiently long, to perfect the knowledge of *Astronomy*, which requires full 600 Years, at the least, to the Observation of all the Varieties of *Cœlestial* Motions: Whereupon he notes, that the Great Year (as they call it) doth consist of six hundred Common Years; the vulgar opinion being, that the *Cœlestial* Motions do continually vary.

cap. 4.

*Donec*

*Donec conſumpto, Magnus qui dicitur, Anno,*
*Rurſus in antiquum redeant vaga ſidera curſum,*
*Qualia præteriti ſteterant ab origine mundi.*

*Epigram. de ætat. Anim.*

Again, the buſineſs might be deduced from not long after the Flood, if in Scripture we could find but the leaſt word from whence might be argued the truth of what the ſame Author writes; namely, that the *Egyptians were taught* Aſtronomy, *by Abraham*. Probable enough it is, we confeſs, that *Beroſus*, and others, quoted as well by *Joſephus*, as *Euſebius*, had read ſome ſuch thing in ſome Book of the old Rabbins: but that the ſame ſhould be fetched from Holy Writ, is moſt improbable; therein being no mention at all of any ſuch thing. Beſides, there are Pious and Learned Doctors, and among them *Salianus*, who will not allow it to be ſo much as probable, that *Abraham* ſhould inſtruct the *Egyptians* in *Aſtronomy*: becauſe of the very ſmall Time of his ſtay among them in *Egypt*. It is written indeed, that *Abraham came from Ur of the Chaldeans*: but not that he received *Aſtronomy* from the *Chaldeans*, or that he delivered it from them to the *Egyptians*. And therefore they conclude, that what *Joſephus* ſaid of *Abrahams* Reading *Aſtronomy* in *Egypt*, may with more probability be imputed to his Great grand-Child, *Joſeph*, Concerning Him, therefore, we read (in truth) that he was ſingularly favourable to the Prieſts in *Egypt*, at ſuch Time, as all the reſt of the People mortgaged their Lands to the King for Bread, during that woful and long Famine. For, He excepted the Lands belonging to the Prieſthood, and (as the Text ſaith) aſſigned them certain Portions out of the publick Granaries; ſo that from hence may be proved (what *Ariſtotle* tells us from other Authority) that amongſt the *Egyptians*, the moſt Ancient Nation, the Prieſts were exempted from Labour, and left to the eaſie employment of their Minds: and that this gave them occaſion to invent and conſtitute the *Mathematicks*: and yet for all this, it is not written, either that *Joſeph* taught thoſe *Egyptian* Prieſts the *Mathematicks*, or that they taught them to him. And perhaps that Favor he ſhewed the Prieſts, was an Argument not only of the Reſpect and Veneration born them by the King and all his People; but alſo of his particular Gratitude toward them; in that He, who had been bred up only to Sheppardry and

*Gen.* 11.

*Gen.* 47.

*I. Polit. cap.* 1. *and Metaph. cap.* 1.

try Imployments, and was wholly ignorant of all Arts and Sciences, at his first coming among them; being afterwards advanced to the height of a Courtier, and lustre of a Favorite, had been instructed by them in something more noble and sublime. And truly the Divine *Moses*, not long after admitted into the same Court, is not delivered so much to have erudited any others, as to have been himself learned in all the Wisdom of the *Egyptians*.

*Acts.* 7. Nevertheless considering that this Wisdom of the *Egyptians*, doubtless contained the *Mathematicks*; and that *Astronomy* was ever esteemed the best and noblest part of them: this Erudition of *Moses* seems to be the most Ancient Monument of the Science of the *Stars*, that can be found in Holy Writ.

*Astronomy* you see is of great Antiquity, even upon the Records of Divinity; and might be proved of much greater, could we but evince (what some alledge) that the History of *Job* was

*Cap.* 9. Pen'd by *Moses*, as living a good while after him. Because *Job* there mentions *Arcturus Orion*, and the *Hyades*, or watery *Constellation*: and therefore it must be, that before that Time the *Stars* had been ranged and disposed into certain *Asterisms*, according to some certain method or artificial Theory then in Use. But be the Time of his life never so uncertain, yet we may certainly observe from the History thereof; that it seems *Job*, being an Alien to the *Hebrews*, derived his knowledge of God from that which in Scripture is called *Cælorum Exercitus* the *Host of Heaven*. For asmuch as the Invisible things of God are not so well learned from any visible things of Nature, or the effects of his Wisdom & Power, as from the *Cælestial* Orders, and therefore *Synesius* justly

*De dono ad Fan.* calling *Astronomy* [ὑπερφυὲς ἐπιτήδευμα] *a truly-venerable Science*; he saith, that it advanceth the Mind to something of greater both Antiquity and Nobility, *viz.* ineffable *Theology*. That we may be brief, and only touch upon that sentence in the Book of *Wisdom* that God gave to *Solomon*, among other of Natural

*Cap.* 7. Sciences, to *understand the Course of the Year, and the dispositions of the Stars*: If any thing in Sacred Writ doth expresly prove the Antiquity of Observations *Astronomical*, and the founding or erecting any setled Art thereupon; it must be that, of which

*Isa.* 47. the Holy Prophets complain'd in their days; *viz.* that there were Chaldeans who at *Babylon did contemplate the Stars, and compute the months, that from them they might foretel things to come.* For, from hence we understand, that the Observations of the Motions of *Heavenly* Bodies was a certain profest Art; and of great

great Antiquity among the *Chaldeans*.

Artic. 3. Ethnick *monuments likewiſe revolved; and firſt thoſe of* Fabulous *times: according to which* Cœlus *is found the moſt ancient Aſtronomer.*

In the *Second* place we are to revolve the Records of *Ethnick Authors*, to ſee if among them we can find the Time of the Nativity of *Aſtronomy*.

Look we therefore back. Firſt, into the Remains of that part of Time, which is called *Obſcure* or *Fabulous*, becauſe poſſibly enough ſomething of Truth, concerning our enquiry, may be found wrapt up in the darkſome ſhrouds of *Fables*. And begin we at the moſt Ancient of Heathen Gods, *Cœlus*, in Greek Οὐρανὸς who, as *Diodorus Siculus* delivers, was ſo named, becauſe of his High Devotion to, and delight in the Obſervation of the *Stars*. This eminent Perſon being the Father of many Sons, as *Atlas*, *Saturnus*, the *Titanes*, and among thoſe, eſpecially *Hyperion* and *Japetus*, it is lawful for us to conjecture, that led by his Example, his whole family were addicted to the ſame Study. For ſeeing, that *Cœlus* lived in *Mauritania*, not far from the Ocean; and thence extended his Kingdom, not only over all *Africa*, but alſo into a conſiderable part of *Europe*: it is well known that his Son *Atlas* who ſucceeded him in the ſame Dominions, is allowed to have given his name to the higheſt Mountain of that Country; only becauſe he had made his Obſervations of the Motions of the *Heavens* and *Stars*, from the top thereof. For the Ancients in thoſe Days, as the Vulgar now in ours, imagined the Arch of the *Heavens* to be ſo little diſtant from the tops of great Mountains, as that by how much the Higher any man aſcended on thoſe Hills, by ſo much the more clearly & diſtinctly might he behold *Cœleſtial* Objects. To this, *Diodorus*, *Pliny*, and others add; that *Atlas* was feigned to ſupport *Heaven* on his Shoulders, only becauſe he had Framed a *Sphere*, wherein the whole *Heavenly* machine was ſtrongly repreſented: and *Clement Alexandrinus* Obſerves, that *Hercules*, being both *Vates* & *Phyſicus*, a Prophet and Philoſopher, was reported to come and relieve *Atlas* (his great Uncle) by taking the vaſt Burden of *Heaven* upon his own Shoulders; becauſe He ſucceeded him in that difficult Task, the Study, or ſcience of *Cœleſtial* Bodies. Of *Heſperus*, the Son of *Atlas*, it is recorded, that while he was buſie in ſpeculating the *Stars*, on the top of the ſame Mountain, he was ſnatched away by the violence of ſome Diſeaſe, & could never be found: & that thereupon, the common People, in reſpect of his Piety and Juſtice, gave his name to the moſt beautiful and reſplendent *Star*, which is alſo called *Veſperugo*, being *Venus*, while ſhe

*and after him his Sons.*

I. Atlas, *who taught Aſtronomy to his Son.*

*lib.* 3.

*lib.* 2. *cap.* 8.

*Strom.* 1.

Heſperus.

*And Daughters, the* Atlantiades *and* Pleiades, *from one of whom came* Mercury. I. Astron.

She is in the *West*. As for his Sisters, called both *Atlantiades*, and *Pleiades*: these likewise gave their name to that Glomeration of *Stars*, which are visible in the Back of *Taurus*, and of one of them, named *Maia*, was born the famous *Mercurius*, said to have brought the Science of the *Stars* first into *Egypt*. Whence *Marcilius*, writing of the *Astronomy* of the *Egyptians*, Says of *Mercury*.

*Tu Princeps, Author q; Sacri, Cyllenie, tanti.* &c.

Though we well know, that the *Ethiopians*, allowing the *Egyptians* to be no other, but one of their *Colonies*, sent abroad to find room to subsist in, contend, that they received *Astronomy* from them: as first *Diodorus*, and after *Lucian* have observed. Here it is well worthy our Commemoration, what *Cicero* saith, as of *Atlas* and *Prometheus*, so also *Cepheus*, a King of the *Ethiopians*: *viz.*

*lib.* 3. *lib. de Astrol.* 5. *Tusculan.*

"Neither had *Atlas* been believed to have sustain'd *Heaven*, nor "*Prometheus* to have been chain'd on *Caucasus*: nor *Cepheus* with "his Wife, Son-in-Law, and Daughter, to have been Stellified: "had not their Divine cognition of *Cœlestial* Bodies first occasi-"oned the perpetuation of their Names in the Disguise of Fables.

2. Saturn, *who delivered the same to his Son.*

To return to *Saturn* another Son of *Cœlus*; He leaving *Africa*, and Reigning only in *Italy*, *Sicily* and *Crete*; may be thought to have prosecuted his Fathers Studies, no less than the former: and we have this Argument for it, that the slowest of all the *Planets* bears his Name, to this very Day: probably, because he was the first who understood the Motion and course of that *Planet*, which was by the *Greeks* called Κρόνος from χρόνος *Time*, forasmuch as of all the *Cœlestial* Circuits, none was found so diuturn. And of his Sons, since *Pluto* addicted himself intirely to *Husbandry*, *Neptune* to *Navigation*, we may conceive, that *Jupiter* applying his mind to nobler cares, succeeded his Father in the Study of the *Heavens*: as also that he chose *Olympus*, accounted the highest Mountain, to make his Observations upon: so that in process of Time he came therefore to be called *Olympus*; and the name of that Mountain to be transferred upon *Heaven* it self, whose orders and laws he well understanding, was thereupon said to have the Dominion of *Heaven*.

Jupiter.

Certain it is, that the *Grecians* ascribed the Original of this noblest Science, partly to the *Gods* themselves, and partly to ancient *Hero*'s; which *Achilles Tatius* seasonably alluding unto, introduceth old *Æschylus* attributing to God, that He shewed the

*Isagog. ad* Phœn.

Risings

Riſings and Setting of the *Stars*, and diſtinguiſht Winter, Summer, and the other Seaſons; and *Ovid* Fathers the ſame wholly upon *Jupiter*.

*Perq; Hiemes, Æſtuſq; & in æquales Autumnos,*
*Et breve Ver, ſpatiis exegit quatuor Annum.* *I. Metamorph.*

Beſides, it is in the Fiction that *Jupiter* took his Father, *Saturn*, bound him, and precipitated him into *Hell*. Now this ſeems to intimate, that *Jupiter* having impoſed his own name upon one of the moſt eminent and illuſtrious of the *Planets*, gave that of his Father to another of them, that was more remote, ſituate in the deepeſt parts of the *Æthereal* ſpaces, and of the ſloweſt Progreſs: though all this while we are not ignorant, that thoſe names were fixed upon thoſe *Planets* a long Time after: ſince more anciently the *Planet Jupiter* was called *Phaeton*, and that of *Saturn*, *Phænon*. For, we may collect very near as much from *Lucian*, who by *Tartarus* underſtands the immenſe Altitude, or Profundity of the *Æthæreal* Region: and ſo denies that *Saturn* was either exil'd by *Jupiter* into *Hell*, or caſt into bonds; as common Heads were perſwaded to believe.

As for *Hyperion*; *Diodorus* hath a Tradition, that he being of the Progeny of old *Cœlus*, demonſtrated the courſes of the *Sun* and *Moon*: and therefore called the *Sun Helios*, after the name of his *Son*; and the Moon, *Selene*, after that of his *Daughter*. 3. HyPerion.

Laſt of all comes *Japetus*, who alſo was the Son of *Cœlus*, but performed nothing worthy commendation in the advance of his Fathers Speculations: but *Prometheus*, whom he Begat, was therefore imagined to have been chained on the Hill *Caucaſus*, and to have his Heart perpetually torn by a hungry *Eagle* or *Vultur*; Becauſe (as *Servius* expounds the Riddle) with reſtleſs care, and ſolicitude of Mind, he conſtantly excruciated himſelf with Obſerving the *Stars*, and Studying their *Aſcenſions* and *Declinations*. We ſhall not inſiſt upon what follows in the ſame Author, namely that this *Prometheus* was the firſt, who introduced *Aſtrology* to the *Aſſyrians* (not far from *Caucaſus*:) it being more uſeful for us now to obſerve, that He was imagined to have ſtollen *Fire* from *Heaven*, for the inanimation of Man, for no other reaſon, but becauſe he infuſed this *Heaven*-fetch't Knowledge into the Breaſts of Men, and inflamed their Souls with the deſire and Love thereof. 4. Japetus. *From whom came* Prometheus, *who followed the ſame ſtudy. in Eccl. 7.*

For,

For, as to the remainder; forasmuch as *Belus* was the ſame with *Jupiter*, among the *Aſſyrians*, as *Diodorus* teſtifieth: it is He rather, who was accounted both the moſt ſacred of their Deities, and the Inventor of this *Sideral* Science; as *Pliny* affirms.

*lib.* 2. *lib.* 37. *c.* 10.

*ſo did* Phaeton.

It is not needful for us here to examine many other of the ancient Traditions, accounted likewiſe among the Fabulous; as, in particular, the Fable of *Phaeton*, which hath this Mythology, that in his Life Time he had made a conſiderable progreſs toward the diſcovery of the *Sun's Annual* Courſe; but dying immaturely, he left the Theory thereof imperfect. That other of *Bellerophon*, whom Interpreters maintain to have been carried up to *Heaven*, not by a Flying Horſe, but a Studious and contemplative Mind, eager in the queſt of *Syderal* myſteries. That of *Dædalus*, who indeed, by the ſame towring Speculations, as by the Artifice of Wings, mounted up to the *Northern* part of *Heaven*; while his leſs ingenious Son, *Icarus*, falling ſhort in his attempt of imitating his Fathers ſublime Flight (as not ſo well underſtanding the Demonſtrations of the reaſons of his Theory) flagged very low in his Studies: and fell from the true and apodictical cognition of *Cœleſtial* Motions and viciſſitudes: with many other the like, recounted by *Lucian*; as that of *Endymion*, the favourite of the *Moon*; of *Tireſias*, the Prophet, &c. Yet one thing there is mentioned as well by *Lucian*, as *Tatius*, which we cannot well paſs by; which falling under the account of Heroical Times, ſeems to come ſomewhat near to that which is called Hiſtorical. And that is the notable Contention that aroſe betwixt *Atreus* and *Thyeſtes* about ſupream Dominion. For when by the publick Conſent and Vote of the *Argives*, the Kingdom was to be his of the Two, who ſhould give the moſt eminent Teſtimony of Science: it came to *Atreus* ſhare to be King: becauſe, though *Thyeſtes* ſhewed them the *Sign Aries*, in *Heaven* (for which he was honoured with a golden *Ram*) yet had *Atreus* declared a thing more excellent; while diſcourſing about the Variety of the *Sun's* Riſing, he made it appear, that the *Sun* and the *World* (*i.e.* the *Starry Orb*) were not carried the ſame, but quite contrary Ways, and conſequently, that that part of the *Heavens* which was the *Weſt* or *Occident* of the *Starry-Orb*, was the very Riſing, or *Orient* of the *Solary*. Hence that Verſe of *Euripides*,

*de Aſtrol. in Iſagog.*

Dædalus, Icarus.

Atreus *and* Thyeſtes.

Δείξας γὰρ ἄστρων τὴν ἐναντίαν ὁδὸν
*Qui Aſtrorum enim contrariam oſtendit viam.*

To

To the same Times likewise are we to refer the Institution of the *Olympick Games*, by *Hercules*: which after a long interruption were renewed by *Iphitus*. For, inasmuch as those Sports were instituted for no other end (as may be assured from *Censorius*) but that their Celebration might put men in mind of that *Intercalation* of a Month and half, that was to be made constantly every fourth Year, in respect of those four Times eleven, or forty four Days, by which the Motion of the *Moon* anticipated that of the *Sun*; and the four times six Hours, or one whole Day, by which the circuit of the *Sun* exceeded 365 Days: manifest it is, that *Hercules* could not understand this, without having first exactly Observed the Motions of the *Sun* and *Moon*. Hither also belongs that which is reported of *Orpheus* who must needs have attentively Observed the seven *Planets* if it be true, as *Lucian* avers, that he represented their Harmony by his *Sevenstringed Harp*: which the *Grecians* thereupon designed in *Heaven*, by some *Stars*, that to this Day retain the name of *Lyra*. So likewise doth what *Sophocles* saith of *Palamedes*, who pointed out the several *Asterisms*, and particularly,

Hercules *and* Iphitus.

*cap.* 18.

Orpheus.

*de Astrol.*

Palamedes.

Ἄρκτου Στροφάς τε, καὶ κύνος ψυκρὰν δύσιν
*Ursum volutam: gelidum & occasum Canis.*

And lastly, what *Homer* recounts, that in those Times were well known (besides *Boetes* and the *Bear*, or *Wain*)

Homer.

Πληϊάδας θ' Ὑάδας τε, τὸ θένος Ὠρίωνος
*Pleiades, atq; Hyades, roburq; ipsum Oriones.*

*Odyss. E.*

We have now struggled through the Darkness of Fabulous Times, and are advanced as far as to discern the Twilight of *Historical*. And here, the first thing we clearly perceive, is that the whole Controversie about the Antiquity of *Astronomical Observations* lies betwixt the *Egyptians* and the *Assyrians*, or *Babylonians*. For, as to the *Grecians*, though some have thought they might put in also for a claim to the Honour of being the Authors of this admirable Science; yet by the Verdict even of *Plato* himself, they are to lay by the pretence of competition; "For, saith He, The first that made *Syderal* Inspections, was a "*Barbarian*, a more Ancient Nation than Ours bred those Men

Articl. 4.

*Secondly, those* Historical *times; according to which, the antiquity of Astron. Observations belongs either to the* Egyptians, *or* Babylonians. *in Epinom.*

 "who

"who first devoted their minds to that Study, in respect of the "*Summer*-like serenity and perspicuity of the *Air*, such as *Egypt* "enjoys, and *Syria*, where all the *Stars* are clearly visible, and "no Clouds or Mists to obscure the beautiful Face of *Heaven*. And certainly, if we except what we newly mentioned, the Institution of the *Olympick Games* by *Hercules*, and the Restauration of them after some Intermission, by *Iphitus*, which hapned about 800 Years before Christ; and some places in the Writings of *Homer*, and more especially of *Hesiod*, who lived near upon the same Time, or not long before; we shall find that the *Grecians* can produce no Monuments of their Observations of the *Heavens* more Ancient than those of *Thales*, who flourished full 600 Years before Christ; and who yet borrowed his knowledge of *Ætherial* Matters from *Egypt*. It being manifest therefore, that the *Egyptians*, or their Priests, are the only Men, that ought to be admitted to dispute with the *Assyrians* or *Babylonians*, or their Philosophers, concerning the Antiquity of Observations, and that their several Pleas seem equally reasonable. Truly, it is no easie matter to determine the difference, so as to place the Lawrel on their Heads to whom it doth of right belong. For, albeit *Josephus* assigns the Honour to the *Chaldæans*; and others again stand firmly for the *Egyptians*: Yet *Plato*, *Diodorus*, *Lucian*, *Achilles Tatius*, and others alledge such quotations for each party, as seem to have no other, but the Authority of the Parties themselves. Nor ought that to seem strange, since both sides equally alledge the convenience of their vast Companies, & the Serenity of the *Sky*; since they both boast themselves the Original Nation, and allow their Competitors to be only *Colonies*; since both glory in Fabulous beginnings, which we cannot trace or discuss; & both recur to egregious falshoods about the time when their Ancestors first made *Coelestial* Scrutinies. For, the *Chaldæans* (as we find in the Register of *Diodorus*) affirm, that their Nation applied themselves to these Studies, from times of Incredible Antiquity, *viz.* of four hundred and 3 thousand Years: And the *Egyptians* (as *Cicero* Observes) talk of Observations of four hundred thousand and seventy Years standing. Unless you shall please to consign the Victory to the *Egyptians*, because they put a value on themselves by Auction. As if it were not enough for them to boast those four hundred nine thousand Years (mentioned by *Laertius*) in which from the time of *Vulcan*, the Son of *Nilus*, to that

1. *Antiq.* 8. in *Epinom.*
2. *lib. de Astrolog. Isagog.*
*Loc. citat.*
*de Divinat.*

that of *Alexander* of *Macedon*, there happened of *Eclipſes* of the *Sun* three hundred ſeventy three, and of the *Moon* eight hundred thirty two. Theſe Conſiderations premiſed, we cannot indeed deny but the *Egyptians* had ſome Obſervations, ſome Ages before *Thales* and other *Grecians* Travelled among them: But when we would enquire more preciſely into the Time, when thoſe Obſervations firſt begun; we find our ſelves at a loſs, and brought back again into the Cimmerian obſcurity of Fabulous Times. *In præfat.*

Now foraſmuch as, tho *Pliny* writes, that *Epigenes* found no Obſervations among the *Babylonians* of above ſeven hundred and twenty Years Antiquity, and thoſe engraven on Artificial Tiles or Slates; and the moſt ancient *Eclipſes* deduced from them, were tranſmitted to *Ptolomy*, about the ſame number of Years before Chriſt; and that by the great *Hipparchus*. And to the ſame Time belongs what *Beroſus* & *Critodemus* ſay, that in their Days there were extant no Obſervations of more than four hundred and thirty Years, as may be found alſo in *Pliny*: Foraſmuch, we ſay, as we have brought ſome conſiderable Monuments of Obſervations much elder than that time; yet ſhall not concede beyond what the *Caldæans* themſelves profeſt, when they teſtified to *Caliſthenes* (who went to them upon no other Errand, by the perſwaſion of *Ariſtotle*, as *Simplicius* relates) that they had nothing of that kind among them beyond a thouſand nine hundred and three Years paſt: Which Years ſeem to commence at *Ninus*, the Son of *Belus*, and firſt King of the *Aſſyrians*. It is clear, that the Antiquity of Obſervations ariſeth to (but not above) one thouſand and ninety Years before *Alexander* the Great. *lib. 9. c. 56.* *In Almageſt. lib. 4. cap. 6.* *In lib. 3. de Cælo, and comment 46.*

But, alaſs! After all this great ado, *What did the Obſervations themſelves amount unto?* Why truly, for ought we can gather from all that is Extant concerning them, thoſe of the *Egyptians* amounted to nothing at all; and thoſe of the *Caldæans* to very little. For the *Egyptians*, we confeſs, are ſaid to have Obſerved the Riſing of the *Dog-Star*, and ſome other, no very difficult Appearances. But we have no remains delivered down to us, of that or any other particular they Obſerved, with the exact deſignation of the Time as they ought. And from the *Caldæans* we have as little, beſides thoſe *Eclipſes* mentioned in *Ptolomy*. But when I ſpeak of the *Egyptians*, I except *Ptolomy* himſelf, and ſome others who lived and Studied at *Alexandria*, about three hundred years before the Nativity of our Saviour; or after *Alexander*: As *Timocharis*, *Eratoſthenes*, Article 5. *Yet neither of them Obſerved any thing conſiderable: As to the deſignation of Times: But corrupted what they had Obſerved, to the Introduction of* Aſtrology Judicial.

nes, *Hyparchus*: for all these were either *Grecians*, or to be accounted among the *Grecians*, in respect of the Language they used and wrote in, rather than amongst the ancient *Egyptians*, by whose Inventions even *Ptolomy* himself (one of their own Country-men, without dispute) was very little, or nothing at all assisted in his Study of *Astronomy*. But, what concerns as well the *Egyptians*, as *Chaldæans*, their Observations are to be distinguished (according to the division vulgarly received) into (1.) *Astronomical*, and (2.) *Astrological*: the former relating to the Motions, Magnitudes, Distances, and proportion of the *Stars*; the Latter to the Effects of them, which they conjectured were dependent on the Vertues and Influences of Heavenly Bodies, as well in the affections of the *Air*, as in the Actions and Affairs of Mankind. For, both Nations being wonderful prone to Superstition, and surprised with excess of Admiration at the *Eclipses* of the *Sun* and *Moon*, when they first beheld them; and Observing ever now and then some *Stars* that moved in Courses contrary to the *West*, they began presently to think, that those Appearances happned not without Natural Causes; and that it remained only on Mans part, to Study how those Events might come to be foreknown which those appearances did portend. Hereupon, having attributed the most powerful Vertue to the five Wandering *Stars* (as *Diodorus* testifieth particularly of the *Chaldæans*) as understanding them to be the Proclaimers of the Will and Purposes of the Gods; because they sometimes Arose, and sometimes Set in various Places of the *Heavens*, because they varied their Magnitude and Colour: therefore they conceived, that they ought to address their Studies and Disquisitions principally to these Varieties. And, because they imagined, that the higher the Place was, from whence they should Observe these Wandering *Stars*, the more clearly and distinctly might they be discerned; they builded Structures of vast Altitude; and particularly that immense Tower at *Babylon*, described by *Herodotus*, from the highest Area whereof (where stood also the Temple of *Belus*) they might exactly Behold and Observe the Rising and Setting of the *Stars*, and other *Syderal* occurrences. They took notice likewise, that those five *Planets* did keep almost the same Course, as the *Sun* & *Moon*, and thereupon they pointed out the *Zodiack*; imagining that there must be some eminent Vertue in that part of the *Heaven*, because all the *Planets* kept constantly to it. And this

*Loc. citat.*

*lib.* 10.

this *Zodiack* they divided into twelve parts, or *Signs*; becauſe the *Moon* run it over twelve times, and the *Sun* only once in one Year: and according to the number of the Days, during which the *Sun* was in paſſing through one *Sign*, they diſtinguiſhed each *Sign* again into thirty parts, which we call Degrees. I ſhall not recount to you, how they would have Twelve Principal Deties belonging to theſe Twelve *Signs*, whereof each had his particular Regiment over his proper *Sign* and *Month* dependent thereupon: nor how they ſubſtituted thirty of the fixt *Stars*, to aſſiſt the *Planets*, and called them *Councelling Gods*: nor how they placed twelve *Stars* always viſible in the *North*, for government of the Living; and as many more in the *South*, always viſible, for the government of the Dead, there gathered together, with many other the like Dreams and ridiculous abſurdities. But the thing I think moſt worthy your notice, is, *by what rude kind of Artifice they diſtinguiſhed the* Zodiack *into Twelve Signs*; as we find it deſcribed, concerning the *Chaldeans*, by *Sixtus Empiricus*, and concerning the *Egyptians*, by *Macrobius*. *ad Aſtrolog.* 1. *in Somn.* 21.

The manner was this, They took a Veſſel with a ſmall hole in the Bottom, and filling it with Water, ſuffered the ſame to diſtil Drop by Drop into another Veſſel, placed beneath to receive it; and this from the Moment of the Riſing of ſome one *Star* or other, Obſerved in one Night, until the Moment of its Riſing again the next night following. The Water fallen down into the Receiver, they divided into twelve equal parts, and having two other ſmaller Veſſels in readineſs, each of them fit to contain one twelfth part of the Water, they again poured all the Water into the upper Veſſel, and ſtrictly marking the Riſing of ſome one *Star* in the *Zodiack*, they at the ſame Moment gave the Water leave to diſtil into one of the ſmaller Veſſels, and ſo ſoon as that was filled, Obſerving likewiſe another Riſing *Star*, they put under another ſmall Veſſel; and ſo alternately ſhifting the ſmall Veſſels, they noted, if not in one Night, yet in many, the twelve *Stars*, by which they might diſcriminate the whole *Zidiack* into twelve equal parts. Now with what Art and exactneſs theſe Ancients meaſured out the *Heavens*, may be conjectured from this one example. I might adſer another foppery of the *Chaldeans*, from the ſame *Empiricus*, who relates, that taking it for granted, that the future Fortunes of Men did depend on their particular *Horoſcope*, or *Sign* Riſing at their Birth: when they had a mind

mind to divine in this Kind. Two of these Wise Men agreed together in the Calculation of the Nativity of the Person proposed: The one stood by the Mother in Travel, the other on some high Place near at Hand, and as he that was below gave the Sign, that the Infant was then newly come into the *World*, the other above took care to Observe the *Sign* that was just then newly Risen. But, it will be of more use for us to hear what *Macrobius* tells of the *Egyptians*. They, when they would know the Diameter of the *Sun*, had in readiness a Vessel of Stone, hollowed to the form of an *Hemisphere*, exactly made, with a *Style* or *Gnomon* erected in the Middle, and twelve Horary Lines drawn within: And on the very day of the *Equinox*, Observing the Moment, when the upper Limbus of the *Sun* first shewed it self above the *Horizon*; they marked that place on the brim of the Vessel, on which the *Gnomon* cast its Shadow. Then again marking that Place, on which the Shadow ended, when the lower Limbus of the *Suns* body appeared just above the edge of the *Horizon*; they measured the space or distance betwxt the two marks of the Shadows, and found it to be the ninth part of an Hour, or the hundred and eighth part of *Hemisphere*, and consequently the two hundred and sixteenth part of the whole Circuit: And from thence they deduced, that the Diameter of the *Sun* was the two hundredth and sixteenth part of its whole *Orb*; (which, in truth, is the 700*th*. near upon) or did contain one Degree and an hundred Minutes; which yet is no more than half a Degree, or 31. Minutes, at most. To this we might superadd, that it was the Practice of Elder Times, to commensurate the Diameter of the *Sun* by an *Hydrologie*, or Vessell of *Water*; collecting the same from part of the *Water* flowing down the whole Day, which had dropped untill the *Sun* was wholly Risen; as is insinuated by *Plutarch*, and deduced from *Capella*: But *Cleomades* hath at large declared, that this way of measuring by *Water* falling slowly and equally from Vessel to Vessel, was an Invention of the *Egyptians*. Now the reason why we touch upon these Particulars, was only to satisfy, that (as we said before) no great matter in *Astronomy* was ever Observed either by the *Egyptians*, or by the *Babylonians*.

*Vid cap.* 20.

And, if you desire any further Argument thereof; Pray take this. They were very far from suspecting, that the Fixt *Stars* had any Motion proper to themselves; or that they had any *Eccentricity*

*tricity* (excepting only that the *Egyptians* thought *Venus* and *Mercury* to Move round about the *Sun*, as their Center; as is affirmed by *Macrobius*, and ſome others) or that the *Sun* had any *Apogæum* at all; with many other particulars fully as conſiderable. Which doubtleſs muſt be the reaſon, why they invented no *Hypotheſes*, by which they might regulate themſelves, in making their Calculations of the various Motions of the *Heavenly* Bodies. And *Peter Ramus* not long ſince complained, that we have not our *Aſtronomy* free from the trouble of *Hypotheſes*; ſuch as the Interpreters of *Ariſtotle* themſelves, and *Proclus* on *Timeus* have Recorded the *Egyptians* and *Babylonians* to have had amongſt them: While, in troth, he Complained, that we had not our *Aſtronomy* as rude, wild and imperfect, as theirs was. For, however ſome *Hypotheſes* are more ſimple (and ſo more eaſy) than other-ſome, yet it is abſolutely impoſſible, that *Aſtronomy* ſhould conſiſt without ſome or other. Hereupon, they could Obſerve, indeed, that the Planets were one while *Direct* in their Progreſs, another while *Retrograde*, and then again *Stationary*; that they in their Wandrings ſometimes inclined towards the *North*, and ſometimes deflected again towards the *South*: but all that while, they could neither comprehend the Reaſons of thoſe various Appearances, nor Calculate them by Numbers. The moſt they could do, was darkly to repreſent thoſe Motions, by certain *Hieroglyphicks*, as in particular by the Windings and flexures of Serpents; and the Motion of the *Sun*, only by a Beetle rowling his Pill of Dung backward: as we may read in *Clemens Alexandrinus*: And then came *Eudoxus*, who having learned the variety of Motions among them, was the firſt who invented *Hypotheſes* of various *Orbs*, for the Solution of the *Phænomena*.

Again, they were very far from attaining the determinate Places of the Fixt *Stars*, according to *Longitude* and *Latitude*, or according to their *Right Aſcention*, and *Declination*: So that neither could they define the true Places of the *Planets*, by Comparation to the Fixt *Stars*, nor (conſequently) deſign any Obſervations with due exactneſs. And truly this was the Cauſe why *Hyparchus* met with no Obſervations either of the *Egyptians* or *Babylonians*, by which he could receive the leaſt help or advantage, toward his compoſing either *Hypotheſes*, or Tables to Repreſent the Motions of the Five Errant *Stars*: And *Ptolomy* was the firſt, who partly by the benefit of Obſervations left

left him by *Hipparchus*, and partly by those he made Himself, became able to attempt such a Work; as stands recorded in his *Almagest*. There were only the the *Eclipses*, which both these Nations had set down, as Observed in their Commentaries: and those only so, as that from Past, they might be able to conjecture something of that were to Come. Not from the Motions of *Sun* and *Moon*, exactly Calculated by the help of *Tables*; but having learned from common experience, that every ninetieth Year, *Eclipses* did return again upon the same Day, for the most part: thereupon they endeavoured to predict what *Eclipses* would happen, and the Time when; and this after they had perceived not any *Anomaly* in the *Sun*, but some certain Inequality in the *Moon*, which reducing to a medium, they concluded that the *Moon* did every Day run through thirteen Degrees, and a little more than one sixth part of a Degree, as *Geminus* delivers of the *Chaldaans*. But in their Predictions of *Lunar Eclipses*, they were somewhat more confident; as well because these *Eclipses* usually return, for the three Ages next succeeding, within the compass of the same Days; as because it is very rare, in respect of the greatness of the *Earths* Shadow, but the *Moon*, either in the whole, or some part of Her, more or less falls into it: but, because (as to *Solary Eclipses*) the *Moon* is both so small, and hath so large a *Parallax*, as that she doth not for the most part intercept the Light of the *Sun* from the *Earth*: therefore was it (as *Diodorus* witnesseth specially of the *Babylonians*) that they durst not determine *Eclipses* of the *Sun* to come, to any certain Time: but if they predicted any, with limitation of Time, they always (to save their credit in case of failing) annexed this Condition, *If the Gods be not prevailed upon, by Sacrifices and Prayers, to avert thm.*

Truth is, these *Astronomers* were also Priests, and it was their interest to cast in this Proviso. For, being ambitious to be reputed interpreters of the Will of the Gods to the People, and so both knowing in things to Come, and skillful in such Ceremonies, wherewith their respective Deities were most atoned and delighted: unwilling to be thought able to predict nothing, and as unwilling again to be found erring in their chief Predictions, they wrapt up all in mysteries, and amused the Vulgar with superstitious Opinions and Rites. The *Egyptians*, in a great part of their Sacred Worship, had recourse to the *Astrological* Books

of

of their *Mercurius* (one of the Order of the Fixt *Stars*; a ſecond of the Conjunction of *Sun* and *Moon*; a third and fourth, of their riſing) which with what Ceremonious Pomp they uſed to carry about with them, in a kind of ſolemn Proceſſion, you may find amply deſcribed by *Clem. Alexandrianus*. Nor is it ſtrange that thoſe Prieſts accounted ſo Sacred and Knowing ſhould alſo be eſteemed for Prophets. Further, you meet with no mention of the Five Errant *Stars*, all this while; and the Reaſon ſeems to be, becauſe they attributed an energie of them only as they were referable to the Inerrant or Fixt: and particularly, as they poſſeſt this or that part of ſome *Sign* in the *Zodiack*, and together with it had their Riſing, or Setting. For, ſo much did they aſcribe to the *Zodiack*, as that the *Babylonians*, and (in imitation of them, the *Perſians* and *Indians*) thought, that each decimal of Degrees, or Thirds of the *Signs* (and the *Egyptians* came as low as to each ſingle Degree) could not be varied in the Riſing, but ſome eminent variation muſt happen, eſpecially in him, who ſhould be born at that Time. And hereupon was it, that the *Egyptians* made that great Circle of Gold (deſcribed in *Diodorus*) of a Cubit in thickneſs, and three hundred ſixty five cubits in Circumference (plundered at laſt by *Cambyſes*) that upon each cubits ſpace might be inſcribed each Day of the Year, 365 Days in the whole round, and alſo what *Stars* did Riſe, what Set upon each Day, nay the very Hour of their reſpective Riſing and Setting, and what they did ſignifie: and whereas others uſed to aſſign the form of ſome Animal or other, to each ten Degrees; they aſſigned one to each ſingle Degree, and ſo made their Hariolations or conjectural Predictions accordingly. For *Example*; to the firſt Degree of *Aries* they aſſigned the figure of a Man, holding a Sickle or Hook in his right Hand, and a Sling in his left; to the ſecond, a Man with a Dogs-head, his right Hand ſtretcht forth, and a Staff in his left, and ſo of the reſt: then annexing the ſignification to each, they determined, that he, who ſhould have the firſt Degrees of *Aries* for his *Horoſcope*, ſhould be ſome part of his life a Husbandman, and the reſt of it a Soldier; that he, who ſhould be born under the ſecond, ſhould be contentious, quarrelſome, and envious; and ſo of the reſt, all which *Scaliger* hath fully deduced from *Aben Ezra*. In a Word; what ever knowledge either the *Egyptians* or *Chaldeans* had of the *Stars*; certain it is, they referred it wholly to

*lib. 6. Aſtronomat.*

*Astronomantie*, or Divination by *Stars*: And therefore amon them there flourish no true and genuine *Astronomy*, but a spurious and false one, *i. e. Astrology Divinatory*, or the fraudulent Art of *Fortune-telling* by the *Heavens*.

*lib. 9. cap. 7.* *lib. 7. cap. 37.* *Berosus* (whom we formerly mentioned) coming into *Greece*, a little after the death of *Alexander*, is discovered to have brought with him nothing solid touching *Astronomy*, but only Judicial *Astrology* for which, as a thing new, and strange to the People, he was highly esteemed, as *Vitruvius* and *Pliny* remark. And *Eudoxus*, who had return'd out of *Egypt* before that, well knew what sort of *Astrology* this was (the Principal Contrivers & Founders of which are said to have been *Petosiris*, *Necepsus*, *Esculapius*,) but he highly contemned it, as *Cicero* remembers, and brought home no other Fruit of his tedious Travels, besides a list of some *Eclipses*, & the varieties of the Motions of the Wandring *Stars*, by which he first essayed to compose accommodate *Hypotheses*, as we have formerly hinted. Nay, *Plato* himself, who was Companion to *Eudoxus*, for thirteen Years together, in *Egypt*, profest, that he could attain nothing solid and satisfactory, touching those *Stars*, and therefore placed all his hope only in the sagacity and industry of the *Grecians*, such as he knew *Eudoxus* to be.

2. *de Divinat.*

*in Epinom.*

"For, having first recounted what ever he knew concerning "them, he saith, it is to be believed that the *Grecians* make more "perfect whatsoever they receive from *Barbarians*; and there- "fore it is fit we allow the same, touching the Argument of which "we have discoursed. Truth is it is difficult to find out the way, "how all these Appearances, so involved in obscurity, may be "explicated: Nevertheless, there is great hope that things of "that sort will be better and more advantagiously Handled, "than they were delivered to us by *Barbarians*.

Articl. 6. *And after them to the* Grecians; *among whom the most ancient mention of Astr. is in* Hesiod.

From the *Egyptians* and *Chaldæans*, therefore (as *Astronomy* Her self, while young and rude) we come to the *Grecians*; and the most Antique Records of *Syderal* Observations to be found among them, seems to be that of *Hesiod*; who in his Book of Weeks and Days teacheth Husbandmen the most opportune Times of Reaping, Sowing, and other Labours of Agriculture, from the Rising and Setting of the *Pleiades*, and *Hyades*, and *Arcturus*, the Dog-Star, and *Orion*:

Ηνικα δ' Ατλαγενεος Πληιονες δυσωσι
*Donec Pleiades, quæ & Atlantiades, exoriuntur*, &c.

And

And I cannot tell, whether it were that Book, or ſome other, that *Pliny* meant, when ſpeaking of *Heſiod*, he ſays, *Hujus quoq; nomine extat Aſtrologia*, there is extant an *Aſtrology* of his. However, we are here to remark two Things, in order to our more exact diſquiſition; the *Firſt* is, that the Ancient *Greeks* principally attended to theſe Riſings and Settings, as well that they might diſtinguiſh the ſeveral Seaſons of the Year, as that they might fore-know Rain, Wind and other diſpoſitions of the *Air*, uſually attending theſe Seaſons. And hereupon, *Thalis*, *Anaximander*, *Democritus*, *Eudemon*, *Meton*, *Eudoxus*, and many others, compoſed certain *Parapegmata*, Tables (as *Ephemerides*, or *Diaries*) in which they inſcribe each Day of the Year, with the particular *Stars* Riſing or Setting on each Day, and what Mutations of the *Air* each one did portend. Such a *Parapegme* as theſe, was compoſed likewiſe by *Julius Cæſar* himſelf, for the *Horizon* of *Rome*; in alluſion whereto he might juſtly own, what *Lucan* ſaid for him,

*Ex. Gem. Ptol. & alii.*

*lib. 10.*

*lib. 1.*

*Nec meus Eudoxi faſtis ſuperabitur Annus.*

And, him doubtleſs, did *Ovid* tranſlate into his *Faſti*: promiſing in the beginning, that he would ſing of the *Stars* and *Signs*, that Roſe and again Deſcended under the *Earth*. But, to keep cloſe to the *Grecians*; among them, he was held a great *Aſtrologer*, who had diſcovered and Obſerved only theſe Riſings and Settings here ſpoken of; and ſo of whom that might be ſpoken, which *Catullus* ſaid of *Conon*.

*Omnia qui magni diſpexit lumina Mundi,*
*Stellarumq; ortus comperit, atq; obitus.*

For, before the Advent of *Beroſus*, this was the only [*Epiſemaſia*] Præſignification or Divination by the *Stars*, the *Grecians* had among them: Unleſs what *Heſiod* hints, in his

*In diebus.*

Πρῶτον ἔνη τετράς τε, ἑβδόμη, καὶ ἱερὴ ἡμαρ,

*Primum prima Dies, & quarta & ſeptima Sacra*, &c.

where he points out, what Days of the *Moon* were accounted Lucky, and what Unlucky.

The *Second* Obſervable is, that among the *Grecians*, and indeed among divers other Nations, beyond all Memorials of either Traditions, or Books, the *Stars* were reduced to certain Images or *Conſtellations*, and denominated accordingly (as their Names yet ſhew) as it pleaſed the fancies of Husbandmen, Shepherds, Mariners and the like, who uſed to be vigilant and gazing upon the *Heavens* in clear Nights. Though there have been ſome *Conſtellations* added of latter Times, as that of the *Leſſer Wain* by *Thales*, which *Laertius* and *Tatius* recite out of *Callimachus*, who alſo took the ſame elſewhere, and that of *Berenices Hair*, removed into *Heaven* by *Conon*, as *Catullus* relates. *Cleoſtratus* likewiſe (as we have it from *Hyginus*) found out the *Kids*: though (which *Pliny* moreover attributes to him,) his invention of the *Signs* in the *Zodiack*, is ſo to be underſtood, as that he taught Men through what *Signs* the *Sun* and other *Planets* paſſed. But (that we may touch alſo upon this) at firſt the *Grecians* had only Eleven *Signs* in their *Zodiack*; and it was Long after ere they came to add the Twelfth, in imitation of the *Egyptians*, who (as may be collected from *Servius*, *Marcianus*, and others) inſtead of the *Claws* of the *Scorpion*, placed *Libra*, the place deſtined to *Auguſtus*, by *Virgil*,

*Lib. 1. de vit. Iſagog. de Com. Beren.*

*lib. 2. Aſtron. lib. 2. cap. 3.*

*in 1. Georg. l. 8.*

*---Ipſe tibi jam brachia contrahit ardens Scorpius.---*

*1. Georg.*

They added the Twelfth, we ſay, to the end, that as the whole Compaſs of the *Zodiack* was divided into *Dodecatemoria* (as they call them) twelve equal Parts, ſo it might conſiſt alſo of Twelve Signs. Albeit, being (as it were) neceſſitated to make uſe of ſuch *Signs*, as had been brought up, rather by chance, than Art; thoſe twelve *Signs* were not exactly proportionate to the twelve Diviſions of the *Zodiack*, but took up more ſpace ſome than others: as in particular, *Leo* poſſeſt more room than *Cancer*, *Taurus* than *Gemini*: I ſay, than *Gemini*, which though compoſed of *Caſtor* and *Pollux*; in ſo little ſpace as is allowed them, it is impoſſible the one ſhould Riſe, when the other Sets, and both in the *Eaſt*: but this *Empericus* interprets of the two *Hemiſpheres*. I omit to inſiſt upon this, that all Nations had not the ſame *Conſtellations*: as among the *Egyptians* was no *Bear*, no *Cepheus*, no *Dragon*, but other Forms or Repreſentations, as *Tatius* reports; and ſhall add only, that *Endoxus* ſeems

*1. Adven. Phyſic.*

to

to have been the firſt, who partly out of the *Egyptians* Figures, partly out of the *Grecians*, finiſhed the whole *Zodiack* with Images reſembling the *Aſteriſms* (as Men had fancied, at leaſt) and cauſed them to be drawn on a *Globe*, or ſolid *Sphere*. For, *Aratus* (upon whoſe Poem, intitul'd *τὰ φαινόμενα*, *Apparences*, there have been ſo many Commentaries ſet forth, as that no fewer than forty have been extant in *Greek*, beſides thoſe of *Cicero*, *Germanicus Avienus*, and other *Latin* Interpreters) did no more, but only expreſs in Verſe, what *Eudoxus* had ſaid before in Proſe, of this Argument; as *Hypparchus*, *Bythinus* demonſtrates. I know not whether it would be ſeaſonable for me, here to advertiſe, that it is no wonder *Aratus* erred ſo groſly in many particulars; conſidering that (as it is written in his Life) he Living with *Antigonus Gonota*, in the quality of his Phyſician, and *Nicander* in the quality of his *Aſtrologer*, and both were good at Poetry: *Antigonus* commanded the Phyſician to give him a tryal of his Poeſie, upon an Argument in *Aſtrology*; and the *Aſtrologer* to give another of his, upon ſomething in *Phyſick*: delivering to the one, the Book of *Eudoxus*; and to the other, all that was extant of *Treacles*, *Antidotes*, or *Counter-poiſons*. So each Wrote of what he did not well underſtand. One thing I ſhall not forget; and that is, that the *Phœnomena* of *Euclid*, who Lived near about the ſame Time, and taught at *Alexandria* (as in the Memorials of *Pappus*) were quite of another kind, being indeed no other, but certain Principles of *Aſtronomy*, concerning the Figure of the *World*, and the Circles of the *Sphere*, and chiefly, that of the *Zodiack*.

*Lib.* 1. *in Arat. Phæn.*

*lib.* 7.

But, to return back to the more Primitive *Greeks*, I remember I ſaid, that *Thales Mileſius* was accounted the Firſt, who after old *Heſiod* and *Homers* Days, enquired into the Order of the *Stars*. And certainly he was the Man, who among the *Grecians* may challenge the Palm, as to Antiquity; for, *Apuleius* calls him, *ut antiquiſſimus, ſic peritiſſimus Aſtrorum Contemplator*, and *Eudemus* in *Laertius* atteſteth, that this was the Opinion of moſt, adding moreover, that *Xenophanes* and *Herodotus* highly admired him, for that he had firſt predicted the *Eclipſes* and Converſions of the *Sun*; and that *Heraclitus* and *Democritus* witneſſeth as much. And whereas *Apuleius* further ſubjoyns, that he found out the Motions and Oblique Tracts of the Syderal Lights, *Pliny* aſcribes that to *Anaximander*,

*And next of* Thales *Mileſius.*

*lib.* 1.

der, a Diſciple of *Thales Mileſius* (whence he was ſaid *Rerum fores aperuiſſe*, to have opened the Doors of *Cœleſtial* Matters) and *Diodorus* to one *Oenopides Chius*: Which *Thales* could not yet be ignorant of the Obliquity of the *Zodiack*, when he had Written of the *Solſtices*, and *Equinoxes*, and had converſed a long Time with the *Egyptians* in their own Country, as *Laertius* remembers. Further it is delivered to us, that among others, he predicted that notable *Eclipſe* of the *Sun*, which hapned in the time of the War betwixt the *Medes* and *Lydians*; which he could not do by any other Reaſon, but only becauſe, coming newly out of *Egypt*, he had Learned, that *Eclipſes* generally return upon the ſame Day after the ſpace of nineteen Years, and having taken notice of one that fell out nineteen Years before, he concluded that there would be one at ſuch a Time. Nor is there Reaſon why any ſhould think, that otherwiſe his whole Life might be ſufficient to Obſerve all the Motions of the *Sun* & *Moon*, as from thence to be able to invent all things neceſſary for the Calculation of Times of their ſeveral *Eclipſes*. Moreover, it doth not appear, how by any other way, but that *Helicon Cyzicenus* came afterward to foretel that *Eclipſe* of the *Sun* (mentioned in *Plutarch*) for which he was ſo much admired by *Dyoniſius*, and rewarded with a Talent of Gold. Nor likewiſe, how *Sulpitius Gallus* could foretel that other of the *Moon*, which as moſt opportunely predicted to the *Roman* Army, then ready to joyn Battel with the *Perſian*, is ſo highly Celebrated not only by *Plutarch* and *Pliny*, but alſo by *Valerius*, *Quintilian*, and other Hiſtorians: For other Rule for the Calculation of future *Eclipſes*, there was none before *Hipparchus*, who invented Hypotheſes and Tables fit for that purpoſe. Beſides, what *Laertius* imputed to *Anaximander*, *Plinius*, as confidently imputes to one *Anaximenes*, an Auditor of his: (namely that he ſhould be the inventor of that *Gnomon*, by which the Converſions of the *Sun* or the *Solſtices*, and *Equinoxes*, were indicated; and that he ſet up ſuch a one at *Lacedemon*.) Near upon the ſame Time was it, that *Pythagoras* is ſaid to have firſt diſcourſed (though *Phavorinus* in *Laertius*, confers that Honour upon *Parmenides*) that *Lucifer* and *Veſper* was one and the ſame *Star* of *Venus*. Now, whether may we conceive, that he borrowed this of the *Egyptians*, from whom being taught, that not only *Venus* but *Mercury* alſo were carried round about the *Sun*, as their Center, ſo that one and the ſame might

*In vit. Dionyſ.*

*Hen of* Pythagoras, *and his Diſciples.*

might be both Morning and Evening-*Star*: Poſſibly, from thence he might take the hint of his Conjecture, that the *Sun* was the Center of not only thoſe two, but of the other *Planets* alſo, and conſequently of the whole *World*: And Moreover that the *Earth* it ſelf, as one of the *Planets*, moved about the *Sun*? For truly, this was an eminent and conſtant Tenent in his School; as may be underſtood, not only from *Ariſtotle* in the general, but alſo from *Laertius*, in particular of *Philolaus*, and from *Archimed.* of *Ariſtarchus*, both *Pythagoras* his Diſciples; that we may not rehearſe all thoſe many paſſages in *Plutarch*, concerning this Memorable particular; nor name thoſe, who held, that the *Earth* was not ſo much moved about the *Sun*, as dayly turned round upon an *Axis* of its own; as *Timæus*, a *Pythagorian* alſo, who is therefore by *Syneſius* eſteemed, after *Plato*, *the moſt excellent Aſtronomer.*

2. *de cœlo.* 13. *de Arenarnum*

Philolaus.
Ariſtarchus.
Timeus.
*De den ad pæcu. in Timæum.*

Furthermore, in the next Age after *Thales*, or near upon, comes *Cleoſtratus* (the ſame who was believed to have deprehended the *Signs* of the *Zodiack*) and he, ſeriouſly remarking that the Intercalation, which as we ſaid was wont to be made every fourth Year, celebrated with the *Olympick Games*, did indeed reſtore the Motion of the *Sun* to the ſame Day again; but did not reſtore the Motion of the *Moon* till the eighth Year, or two *Olympiades*, in which the Intercalatory Days amounted to ninety Days, or three Months: He, we ſay, thereupon introduced, inſtead of the *Tetaeteris*, or ſpace of four Years, the *Octaeteris*, or ſpace of eight Years, which compleatly paſt, the *New-moons*, and *Full-Moons* would return again on the ſame Days. But, when in ſhort Time Men had perceived, that this Inſtitution failed them, in exactneſs of Computation; and that ſundry ways had been attempted to cure this uncertainty, at length riſeth up *Meton*; ſomewhat more Antient than *Eudoxus*, and he demonſtratteth from the *New-Moons*, and *Full-Moons Eclyptical*, that they did not return upon the ſame Days, till after full nineteen Years: And thereupon he became the Author of the *Ennea decaeteris*, or *Period*, or *Cycle* of nineteen Years. In reſpect of which diſcovery, together with the *Heliotrope*, or *Sun-Dyal* he made at *Athens*, and ſome other the like Inventions, he was in eminent eſteem among the *Athenians*. But as concerning that *Period*, *Callippos*, familiarly acquainted with *Ariſtotle*, diſcovering it to be too Long by the fourth part of a Day, inferred that from four *Periods* one whole

*After theſe ſucceeded* Cleoſtratus.

Meton, *&c.*

Day

Day ought to be detracted: and ſo erected a new *Period* or *Cycle* of Sixty ſix Years, or four times nine; at the end of which, one Day was to be cut off; and this was called the *Callippick Period*, and remained in Uſe for a long time together. After him, ſucceeded *Hipparchus*, who detecting this *Period*, to be yet too Long; demonſtrated that after four *Callippick Periods*, or three hundred and four Years, there would remain one whole Day too much. And in truth, the Experience of many ſucceeding Ages declared, that to this detraction of *Hipparchus*, nine or ten Years over and above were to be expected. However, it is worthy our Notice, that the *Period* of *Meton*, together with the Connection of it, applied by *Callippus*, was of long uſe in the Church, under the name of the *Golden Number*: though wanting the Application of *Hipparchus* his Correction: alſo, a miſtake of about four Days, relating to the *New* and *Full Moons*, crept into the Account, even from the Time of the *Nicene* Councel, which was one of the two main Cauſes of the Reformation of the *Kalendar* in the eighty ſecond Year of the laſt Age.

Articl. 7. Eudoxus, *who firſt diſcovered the neceſſities of manifold* Spheres.

And now we have an opportunity to ſpeak more expreſly of *Eudoxus*, ſo frequently mentioned. This man, well underſtanding after his Return out of *Egypt*, that not only the *Sun* and *Moon*, but alſo the five Errant *Stars*, did keep their Courſes round in the *Zodiack*; and ſo, as that as well the *Sun* and *Moon*, as thoſe wandring *Stars* did ſometimes vary their *Latitude*, or deviate from the *Ecliptick* Line in the middle of the *Zodiack*: (for, he thought the *Sun* was alſo extravagant, as well as the reſt;) and again, that the other *Planets* did not only go forward, but were alſo ſometimes upon their Retreat backward; and ſometimes made a Hault or ſtood ſtill: we ſay, pondering all thoſe various Motions in his Mind, and caſting about what might be the Reaſons thereof in Nature, he at laſt imagined to himſelf, that beſides the *Aplanes* or *Sphere* of fixt *Stars*, which being ſupream, carried all the reſt toward the *Weſt*, there ought alſo to be allowed three other *Spheres*, as well to the *Sun* as to the *Moon*, and four to each one of the other Errant *Stars*, of which one and that the Higheſt, ſhould follow the Impreſſion of the *Fixt Stars*, or rather of the *Primum Mobile*, the next to that ſhould move Counter to the Firſt, or toward the *Eaſt*; the third makes the deviation from the *Ecliptick*, or middle of the *Zodiack*; and the fourth, or loweſt, cauſe in the *Stars* their *Direction*, *Station* or *Retrogradation*, and that by

by a certain Vibration, or Waving to and agen. So that he ſuppoſed in all, twenty ſeven *Spheres*, and all thoſe Concentrical, that the Superior might carry on the Inferior, and theſe might be turned round within thoſe. Afterwards *Callippus* adjoyned two *Spheres* to the *Sun*, two to the *Moon*, and one a piece to *Mars*, *Venus*, and *Mercury*, and ſo made thirty there: And *Ariſtotle*, to all the *Spheres*, which did not follow the Motion of the *Aplanes*, or *Primum mobile* (excepting only the *Lunar Spheres*) added as many more, which he called the *Revolvent* ones, to the end he might conform them to the Motion of the Inerrant *Sphere*, or *Primum mobile*: and ſo in the whole he conſtituted Fifty ſix *Spheres*, foraſmuch, at leaſt as we can collect from his own context. Now all theſe, and even *Plato* himſelf likewiſe, thought that the *Moon* was the loweſt of all the *Planets*; next to her, the *Sun*: and above the *Sun* the five Wandering *Stars*: Nor indeed doth it appear, that *Archimedes* himſelf Living a whole Age or two after them, repreſented the *Planets* in any other, than this very Order, in that ſo famous *Sphere* of his. In which though *Claudian* tells us, that no more was repreſented, but only the Motions of the *Sun* and *Moon*;

*Percurrit proprium mentitus Signifer annum,*
*Et ſimulata novo Cynthia menſe redit:* *In Epigram.*

Yet *Cicero* adds other Motions, when ſpeaking of *Archimedes*, "he ſaith; when he Collected together the Motions of the *Moon*, *De divinat.*
"*Sun*, and five Wandering *Stars*, he did the ſame as that God,
"who in *Platoes Timæus* framed the *World*, that one and the
"ſame Converſion might regulate ſundry Motions, moſt dif-
"ferent each from other in Slowneſs and Swiftneſs. But *Hypparchus* afterwards finding, that as well the *Sun* as the *Moon* and the other five *Stars*, did come ſometimes nearer to the *Earth*, and ſometimes again mounted up farther from it; and plainly perceiving that that particular Appearance could not poſſibly be explicated by thoſe *Spheres*, that were all Concentrical to the *Earth*: therefore, wholly rejecting them, he reſolved, that the Motions of the *Planets* were to be accounted *Eccentrick*; and though he could not himſelf determine each particular, he yet demonſtrated the *Way*, in which *Ptolomy* afterwards inſiſting, accompliſht

the Invention. But before we advance further, we are to Commemorate two or three Persons of Note, by whose Observations both *Hypparchus* and *Ptolomy* profited very much. One was *Timocharis*, who about three hundred Years before Christ, among other things relating to the Fixt *Stars*, Observed that that *Star* which is called *Spica Virginis*, doth antecede the Point of the *Autumnal Equinox*, by eight Degrees. And with him are we to joyn *Aristillus*, whose Observations of some thing about the Fixt *Stars Ptolomy* made great use of, in order to his Demonstrating that the Fixt *Stars* never change their Latitude. Afterwards (scarce an Age) succeeded *Eratosthenes*, who being *Library-keeper* to *Ptolomy Evergeta* the former, perswaded him to set up the *Armillæ* in the *Porticus* of *Alexandria*; which *Hypparchus* and *Ptolomy* afterwards made use of; and himself among other things Observed, that the Oliquity of the *Zodiack* was of Twenty three Degrees, and fifty one Minutes; which account *Hypparchus* and *Ptolomy* constantly adhered to.

Ptolom. *lib.* 1. *cap.* 11.

Articl. 8. Hypparchus, *who first observed the places of the Fixt Stars, according to Longit. and Latitude*

Now that we may at length remember the great *Hypparchus*, who flourish't near upon an hundred and forty Years before Christ: truly, we find it no easie task to recount, how highly *Astronomy* was beholding to him. For, in the first place, Examining that foresaid Observation of *Timocaris*, with some others, albeit he could not conceive them to be in all points exact, yet because himself had found that *Spica Virginis* did not antecede the *Equinoctial* point by more than six Degrees, and the other *Stars* in the like proportion: He hence understood, that the Fixt *Stars* also were moved *Eastward* according to the *Zodiack*; and thereupon wrote a Book, of the *Transgression of the Solistices and Equinoxes*. And, being that in his Time, as not long ago in *Tycho Brahes*, there appeared a certain *New Star*, he "therefore "came to doubt (to speak the Language of *Pliny* concerning "him) whether the like happened often or not; and whether "those *Stars*, that were thought to be fixt, had also some certain "Motion peculiar to themselves. Wherefore (as the same *Pliny* "goes on) he attempted a task of difficulty sufficient even for "the Gods themselves, namely to number the *Stars* for Posteri-"ty, and reduce the Heavenly Lights to a Rule, so that by the "help of Instruments Invented, the particular Place of each one, "together with its Magnitude, might be exactly design'd: And "whereby men might discern, not only whether they disap-

*lib.* 2. *cap.* 25.

peared,

" peared, or newly appeared, but alſo whither they Removed
" their Stations; as likewiſe, whether their Magnitude Encrea-
" ſed, or Diminiſhed; leaving *Heaven* for an Inheritance for the
" Wits of ſucceeding Ages, if any were found acute and induſtri-
" ous enough to comprehend the myſterious Order thereof.
" And this was the firſt Time when the Places of the Fixt *Stars*
were Obſerved and markt out according to *Longitude* and *Lati-
tude*: And that *Catalogue* of the Fixt *Stars*, which he Compoſed,
is the very ſame, which *Ptolomy* afterward inferred into his *Al-
magiſt*. In the next place, he denoted what poſitions ſundry
*Stars* had in reſpect each of other: Whether they were poſited in
a right Line; or in a triangular Form; or in quadrate or ſquare,
&c. As is manifeſt even from *Ptolomy* himſelf. Further, tho'
the Motions of *Sun* and *Moon* were already in ſome meaſure
known; yet he made that knowledg much more exact. For, he
did not only much Correct the *Calippick Period*, formerly ſpoken
of, but alſo, having Collected a long Series of *Eclipſes* (namely,
from the Time of thoſe *Babyloniſh* ones, in the Days of *Mardo-
cempades*, down to thoſe Obſerved By himſelf, for full ſix hun-
dred Years together) and remarking, that neither the like *Eclip-
ſes* did Return on the ſame Days, after the ſpace of every nine-
teen Years, nor that after ſome recourſes of ten *Novennales*, or
ten times nine Years, any ſuch *Eclipſes* happened at the times
ſuppoſed; and that the Cauſe thereof conſiſted both in the vari-
ous *Latitude* of the *Moon*, and the Anticipation of her *Nodi* or
Knots, and her Eccentricity, by reaſon whereof her Motions to
her *Apogeum* were found to be ſometimes ſlower, and thoſe to
her *Perigeum* more ſpeedy: Therefore, we ſay, he comprehended
and gave Reaſons for all theſe Difficulties, and compoſed certain
Hypotheſes, and according to them, certain Tables, by which
he could ſafely and exactly Calculate and Predict what *Eclipſes*
were to follow, how great they were, and when. And this was it
which *Pliny* remembred, when having ſpoken of *Thales*, and
*Sulpitius Gallus*, he comes to mention *Hypparchus*, " After theſe
" (ſaith he) *Hypparchus* foretold the Courſes of both *Lumina-
" ries*, for ſix hundred Years to come; comprehending the
" Months, Days, and Hours of Nations, and the Situation of
" Places and turns of People: His Age teſtifying that he did all
theſe great things, only as he was partaker of Natures Counſels.
For, it muſt be that *Hypparchus*, beſides the preciſe Times, when

*lib. 7. cap.* ibid. *cap.* 1.

*He corrected the* Callipick Period, *& predicted future* Eclipſes, *for* 600 *Years together.*

such *Eclipses* were to be Visible to the *Hor.* of *Rhodes*, or *Alexandria*, pointed forth also some Countries, & principal Cities, together with the Designation of the Months in use among them; as also the very Days and Hours when each *Eclipse* would happen; and other Prædictions succeeding to *Rome*, in the Days of *Pliny*.

Again, it is well worthy our recital, that *Hypparchus* labouring with long Desire both to constitute *Hypotheses*, and reduce into Tables the Motions of the other *Planets*, or five Wandering *Stars*; and yet not being able to furnish himself either from the *Egyptians*, or from his Country-men the *Grecians*, with any competent Observations respective to those *Planets* (for while the places of the fixt *Stars* remained unknown, it was impossible any such could be made) and again those he had himself made, were of much shorter Time, than was requisite for the establishing any thing certain and permanent in that sort: He therefore only digested such Observations as he had recorded by him into the best Order and Method he could devise; and so left them for their Use and Improvement, who should come after him, in case any were found capable of understanding and advancing them. And at length, by good Fortune, it so fell out, that those his Observations came into the Hands of *Ptolomy*, who comparing them with his Own, and finding them Judicious and Exact, thereupon first began to erect both *Hypotheses* and Tables of Motions fit for those *Planets*: yet not without much timerousness and diffidence; because his Observations being but few, nor of sufficient Time, he durst not promise himself any certainty of his Tables for any considerable Spaces, or number of Years. But for more assurance let us hear his own ingenious Confession in that point, "The Time (saith He) from whence "we have the Observations of the *Planets* set down, is so vastly "short in comparison of the greatness of *Cœlestial* vicissitudes, "as that it renders all Predictions, that are for any great num- "ber of Years to come, infirm and uncertain. And therefore I "judge that *Hypparchus* (that zealous lover of Truth) consider- "ing this difficulty, and withal receiving not so many true Ob- "servations from the Antients, as he bequeath'd to us, under- "took indeed the business of the *Sun* and *Moon*, and demonstra- "ted that it might be performed, by Equal and Circular Mo- "tions: yet, as for that of the *Planets*, those Commentaries of his "which have come into our Hands, clearly shew, that he at-

*Almagest. lib. 1. cap. 2.*

tempted

"tempted it not: but collecting all his own Obſervations con-
"cerning them, together in one order and method, for their
"more commodious uſe, reſigned them to the induſtry of after
"Times, having firſt demonſtrated, that they were not congru-
"ous to thoſe *Hypotheſes*, which the *Mathematicians* of thoſe
"Days made Uſe of. And, for others, ſure I am, that either they
"demonſtrated nothing at all, or elſe only attempted the buſi-
"neſs, and left it unfiniſht. But *Hypparchus* being eminently
"knowing in all kinds of Learning, conceived, that he ought
"not (as others had done before him) to attempt, what he
"ſhould not be able to accompliſh. So that we ſee, *Ptolomy* was
the firſt, who from true Obſervations, reduced the Motions of
the *Planets* into *Hypotheſes* and Tables correſpondent.

Articl. 9. *Betwixt Hypparchus and Ptolomy, came Soſigenes of Alexandria, by whoſe help J. Cæſar endeavoured the reformation of the Calendar.*

But before we ſpeak more particularly of him, who Lived about an hundred and thirty Years after Chriſt, foraſmuch as in the ſpace of Time betwixt *Hypparchus* and *Ptolomy*, theſe Studies ſo Flouriſht at *Alexandria*, as that *Julius Cæſar* returning thence, brought along with him that *Soſigenes*, by whoſe Aſſiſtance he endeavoured the reſtitution of the *Calendar*, and ſo may be thought to have propagated the Study of *Aſtronomy* among the *Romans:* Let us reflect a little upon that Time, and ſee what care they then had of *Cœleſtial* Matters In the firſt place, We are to lay aſide the Commemoration of *Sulpicius Gallus* (of whom more than once afore) as one that falls not under this account, concerning whom we may not yet forget, what *Cato* is induced by *Cicero*, ſaying, While we ſaw that *Gallus* Dye, that Familiar Friend of thy Father, *O Scipio*, who was reſtleſs in Meaſuring *Heaven* and *Earth*; I ſay, while we ſaw him Dying even in that Study; How often did Day oppreſs him, when he had ſet himſelf to Obſerve and deſcribe ſomething in the Night? and how often did Night oppreſs him, when he had begun his Speculations in the *Moon?* How was he delighted, when he had a long Time before predicted to us *Eclipſes* of the *Sun* and *Moon?* &c. For he was a Man clearly ſingular, and in an Age when ſo great Ignorance and negelect of good Arts tyrannized over Mens Minds, being himſelf Studious and Inquiſitive, could not but have borrowed his Skill either from *Egypt* or *Greece*, where having obtained a *Series* of *Eclipſes*, and the Way of deducing them through the Circuit of nineteen Years (as we ſaid before) he became able to Calculate them, ſo as *Cicero* relates. For, as to the reſt; how great

do

do you think was the Ignorance and neglect, nay even Contempt of Studies of this Nature among the *Romans*? Why truly so great, as that *Virgil* could not dissemble it, in the Poesy attributed to *Anchisa*; according to which the *Romans* should indeed come to Rule the *World*; but yet should yield to others in Learning to know the *Stars*, and describe the *Heavens*.

6. *Æneid.* — *Cœliq; meatus*
*Describent radio, & surgentia sidera dicent.*

And *Cato* himself is cited by *Agellius* to have left in Writing, that it was not Lawful to Write what is in a Table kept by the
*lib.* 2. *cap.* 28. High Priest: How often scarcity of Provision would happen; How often the Light of the *Sun*, or *Moon* should be Darkned: So far, saith *Gellius*, did *Cato* contemn the Science of *Astronomy*, and thought useless either to know, or fortel the *Eclipses* of *Sun* and *Moon*. Furthermore, though from Times as high as *Numa*, the *Romans* made several Intercalations; yet they took all their Art of that sort, from the *Greeks*: And *Pliny* Remarks, that in *France*, *Spain*, and *Africa*, there was not one Man, who could so
1. *Meteor.* 7. much as tell the Rising of the *Stars*. Nevertheless we are not to
Pythias Massilienſius, *a* Gaul *and contemporary to* Alex. *of* Maced. forget, that among the *Gauls* was one *Pythias*, the *Phylosopher* (as *Cleomedes* calls him) of *Massilia*: Who about the time of *Alexander* of *Macedon*, found the Proportion of the *Gnomon* to the *Solsticial* Shadow, to be the same at *Massilia*, as *Strabo* tells us *Hypparchus* had Observed it at *Byzantium*; who first attempted the *Northern Ocean*, and Discovered the utmost *Thule*, in which *Cleomedes* coherently proves the Summer *Tropick*, to be the same with the *Polar*, or greatest of always apparent ones: And who (as from his Book, *de Oceano*, may be inferred) was exceedingly
*lib.* 7. *cap.* 60. curious to find out what was the Position of *Heaven*, respective to the variety of Countries and *Climates*. But, not so soon to digress from the *Romans*, *Pliny* delivers, that in those first Times of *Romes* being a Common-wealth, the Invention of *Dials* was very Raw and Imperfect; For that they had only the Risings and Settings named, out of Twelve Tables. That after some Years, they added the *Meridian*, and by the indication of a certain column, the last Hour: Nor that neither, but only in clear Weather, even as long as till the first *Punick* War. Afterward they

they advanced ſo far, as to make one, on two *Sun-Dials*; but not with *Lines* exactly correſpondent to the Hours, until about an Age after, when *Q. Marcus Philippus* ordered the Buſineſs more diligently and ſucceſsfully. And, becauſe the Hours of the Day remained yet uncertain in Dark and Cloudy Weather, *Niſica Scipio* began to divide the Hours of Day and Night equally, by Water Diſtilling from Veſſel to Veſſel, and called it *The Dial within Doors*, in the Year *Urbis conditæ DXCV.* And till then, ſaith *Pliny*, *Populi Romani indiſcreta Lux fuit*. And thus much of *Hypparchus*, and ſome *Aſtronomers* betwixt him and the Prince of them all, *Ptolomy*.

Quintus *Marcius Philippus, &c.* Naſica Scipio, Romans.

And of him, ſo great is his Name, all we need to ſay, is only that he was the *very Founder of the Art*, or *Science of Aſtronomy*. For, tho *Hypparchus* had indeed, as it were hewn out the Stones and Beams fit for ſo Noble a ſtructure, and prepared good part of the Materials; yet was it *Ptolomy* alone who put them into Order and Form, and by adding many admirable Inventions of his own, by infinite Labour and Coſt, Erected that ſo famous Building, worthily called Μεγάλη Σύνταξις, *the great Co-ordination, Conſtruction*, or *Compoſition*: Which conſiſting of no leſs than thirteen Books, contains all the Doctrine, that could then be advanced, concerning the *Sun*, *Moon*, and as well the Fixt, as Wandering *Stars*. And, albeit one Day teacheth another, and that (as himſelf had truly foretold) there came others after him, who ſaw good cauſe for the Caſtigation and Correction of many things delivered in that Work: Yet, in the general, the Art he had inſtituted, remained Firm and Conſtant, and was afterwards imbraced, not only by the *Alexandrians*, but alſo by all the *Arabians*, *Latins* and others, who devoted themſelves to the Service of *Urania*, ever ſince. For, that the Study of her *Cœleſtial* Myſteries continued in great Eſteem and Veneration, at *Alexandria*, for ſome Ages after his Deceaſe, may be undeniably atteſted, not only from hence (but among others) both *Theon* and *Pappus*, named *Alexandrians*, were eminent therein; of which the one put forth eminent Commentaries upon *Ptolomies* Works, and the other, among ſundry excellent Pieces, of which his ſixth Book of *Mathematical Collections* is one, obſerved, that about four hundred Years from Chriſt, the *Obliquity* of the *Ecliptick* was not ſo great, as *Eratoſthenes*, *Hypparchus* and *Ptolomy* had conceived: But near upon the ſame we diſcover it to be in our Days

Articl. 10. Ptolomy, *the true Founder of* Aſtronomy *in one intire ſtructure.*

*Who next ſigned it to* Theon *and* Pappus, *both* Alexandrians.

Days: we say that this is not the only Monument that is extant of the Flourishing of *Astronomy* at *Alexandria*; long after *Ptolomy* had given it so great a Reputation there, but there remains another as Fresh and lively, which is the Memorials of those *Patriarchs* of the *Alexandrine Church*, to whose Judgement the determination of that great dispute about the true Time of *Easter*, was thought fit to be wholly referred; as well by the *Nicene Councel*, as by divers Learned *Bishops* afterwads; and by *Holy Leo* himself, then *Pope*. Now, among these *Patriarchs* were *Theophilus*, *Cyrillus*, and *Proterius*, whose advice and directions were thought necessary, in regard that the Controversies raised about the Celebration of *Easter*, about the Time of the *Vernal Equinox*, about the *Full-Moon* next following, and about constituting certain constant Rules respective to them; could not be better composed, than by the definitive sentence of these Prelates, who Living at *Alexandria*, where *Astronomy* was in such Height, had the advantage of Others, in point of knowing those things which were requisite to the finding out of the Truth. But, of the *Arabians*, who in the Study of *Astronomy* succeeded the *Alexandrians*, and translated into their own Language, the *Great Composition* of *Ptolomy*, which they called *Almagestum*; the First, and most worthy to be remembred, was *Albategnius*, otherwise called *Mahometes Arabensis*, born of a Family of the *Dynastæ* of *Syria*; He about 800 Years after Christ, made divers *Cœlestial* Observations, partly at *Arzata*, and partly at *Antioch*: and found both that the *Apogeum* of the *Sun*, since the Days of *Ptolomy*, was advanced to the following *Signs*; and that the *Stars* did regress toward the *East*, one Degree, not in the space of a hundred Years, as *Ptolomy* also had designed; but of somewhat less than seventy: as also, that the Obliquity of the Ecliptick, according to *Pappus* his Theory, was less (*viz.* above 23 Degrees 35 Minutes) with many other particulars concerning as well the *Fixt Stars*, as the *Planets*: whereupon he both Corrected *Ptolomy* in many things and composed new Tables, and wrote a Book intituled, *De scientia Stellarum*. After him, within two or three Ages following, succeeded *Alphraganus*, *Arzachel*, *Almeon*, and other *Arabians*, among whom (as being already tainted with that superstition which had corrupted the simplicity of *Astronomy*, with *Astrological* Fooleries) some certain *Jews*, as ambitiously affecting the glory of Divination as the others, intermixed themselves.

*And long after, to* Albategnius *then to*

*Alphraganus and other* Arabians.

After

After them, for a long time, the Worſhip of *Urania* lay neglected, nor did *Aſtronomy* receive any the leaſt (conſiderable) advantage by Obſervators; till near about four hundred years ſince, *Alphonſus* King of *Caſtile* and *Leon*, being himſelf alſo toucht with the curioſity of *Aſtrological* predictions, and diſcovering that the Tables as well of *Ptolomy*, as *Albategnius* were not exactly agreeable with the Cœleſtial motions; ſet himſelf to the compoſing of new ones; & to that purpoſe convocated as many *Arab.* & *Jews* as were eminent in thoſe Days for *Aſtron.* employing them about Obſervations neceſſary to ſo great a Work, and comparing with them thoſe of their Predeceſſors, that ſo they might be the more exact in the performance of their task propoſed. And very memorable it is, that (as hath been credibly reported) He ſpent four hundred thouſand pieces of Gold on that undertaking: a munificence truly worthy the Heroick mind of ſo great a Prince, and which well deſerves to be had in perpetual commemoration by all lovers of Learning: but ſomewhat unhappily imployed, in reſpect the Perſons ſet a Work were not ſo ſtrict in ſtudiouſly and conſtantly obſerving, as ſcrupulouſly computing, directing their calculations not ſo much to what themſelves and others had really obſerved, as to certain traditional myſteries or Cabaliſtical dreams: that we may paſs by their heedleſneſs, which *Regiomont.* detecting, perceived, that they had miſtaken the true places of the Fixt Stars, by very near two whole Deg. accounting the numbers of *Ptolomy*, as if they had been conſtituted by him from the beginning of the Years of Chriſt. Which conſidered, we have the leſs reaſon to wonder, if the Tables compoſed by them, called from the Kings name, the *Alphonſine*, and ſometimes from the place, where they were made, the *Toletan Tables* (whence alſo He, who was Preſident of that aſſembly of *Aſtron.* is ſaid to have been one *Iſaac Chanter* of the *Toletan* Synagogue) have been found, ever ſince the time of K. *Alphonſus*, to diſagree with the Heavens, and to require the review and caſtigation of ſome new and more faithful hands. Thence forward *Aſtron.* lay neglected, and almoſt buried in Oblivion (only *Thebitius* an *Arab.* and *Prophatius* a *Jew*, obſerved in the mean time ſome ſmall matters, about the motion of the Fixt Stars, and the Obliquity of the Ecliptick,) until about two hundred Years ſince, *Georgius Peur-bacchius*, and *Joh. Regiomontanus*, his diſciple, ſeemed to revive it. For theſe worthy men delivered it out of the double cloud of ignorance and vanity, which the *Arabians* and *Jews* had

Articl. 11. Alphonſus K. of Caſtile, who made and named the Alphonſine Tables.

*After whom the Science lay neglected, till,* Georg. Peurbacchius *and* Joh. Regiomontanus *aroſe.*

*and again cultivated the same.*

raised to the Observations of its Lustre; and kindled the Light thereof afresh in *Germany*: reducing *Ptolomy*, providing Instruments, and making not a few faithful Observations: though they were not so Happy, as to bring their design to that perfection they hoped and had proposed to themselves; both of them dying in the middle and Flower of their Age.

Articl. 12. *Then followed the most acute* Nich. Copernicus, *who revived the Doctrine of* Pythagoras, *concerning the Earths motion.*

Animated by their example, *Nicholaus Copernicus* (a *Borussian* born, and *Canon* of the *Cathedral-Church* of *Wormes*, situate near *Fruemburgh*, in the same Country) about the beginning of the last Age, seriously addressed himself to the Illustration of *Astronomy*, and reviving the long neglected Systeme of the *World*, excogitated by *Pythagoras*, he made many good *Observations*, in order to the composing of new Tables. But, forasmuch as he could not determine any thing concerning the *Fixt Stars*, besides their *Promotion Eastward*, which they appeared to have made since *Ptolomy*'s time; he therefore composed some *Canons* of their motions, and those as exact as possibly he could: yet both those, and the *Frutenick Tables* that were built upon them were incorrespondent to the motions of the Heavens, though less incorrespondent than the *Alphonsine*. Nevertheless, the man is to be highly commended, both for his sublime perspicuity, and modesty, in that foreseeing his *Canons* would need correction, he was wont frequently to exhort and encourage that ingenious young man, *Georgius Joachimus Rheticus*, deeply enamoured of the Beauties of *Astronomy*, to apply himself principally to the Restitution of the *Fixt Stars*, and chiefly of those, which were in the *Zodiack*, or near it, and with which the *Planets* might be most conveniently compared: Because, without their Restitution, it was impossible either to attain to the true Places of the *Planets*, or to atchieve any thing of Moment or certainty, toward the Advance of *Astronomy*.

Articl. 13. *And last of All, the noble* Tycho Brahe, *who out-did all the rest in discoveries and inventions.*

And then at last enters that Noble *Dane Tycho Brahe*, upon the Theatre of *Astronomy*. Who (as he in the impulse of his Genius) was addicted to Beholding and noting the *Stars*, even almost as soon as he saw the light of them; was so much the more spurred on by that advice of *Copernicus*, published in the Works of *George Joachim* newly mentioned, by how much the more clearly he discerned the impossibility of determining the true and proper place of that famous *New Star* (appearing in the *Constellation* of *Cassiopea*, from the beginning of *Novemb.* in the Year MDLXXII. for above sixteen Months together) without the

the reſtitution of the *Fixt Stars* to theirs. For, He plainly perceived, that moſt, if not all the Errors, which had been found in *Aſtronomy*, even from its firſt Foundation or Original, took their riſe chiefly from hence, that the *Fixt Stars* really were not in thoſe places, in which they were ſuppoſed to be by Obſervators; But ſome of them were much nearer, and others again as much farther off; and this, whether becauſe *Hipparchus* in the beginning had not with due exactneſs conſigned all the *Fixt Stars* to peculiar places, which indeed he had deſigned by the *Sextants* of Degrees (and truly it is very difficult at once to Invent any thing of Moment, and Perfect the Invention) or whether becauſe the Tranſcribers of *Ptolomy*, out of careleſneſs, or ignorance, had corrupted the Original Text in many places; or whether the Additions afterward made, in reſpect of the *Stars* progreſs to the following *Signs*, had occaſioned any miſtake and Imperfection in that Theory; or whether by any other unhappy Cauſe whatever. Now, in Order to this great Work, of Rectifying thoſe Fundamental Errors, it pleaſed the Fate, that about the very ſame time, that truly Generous and never enough Commendable Prince *W. Landgrave* of *Heſſia*, had zealouſly devoted his Mind and Induſtry to the ſame care, of reſtoring the *Fixt Stars* to their true Manſions: But yet the Honour he aimed at, was decreed only for the Incomparable *Tycho*; who in an Heroical bravery of Soul, had now reſolved with himſelf to enterprize no leſs than the Inſtauration of the whole Science of *Aſtronomy* from its very Fundamentals; and ſo to ſpare neither Labour, nor Coſt (eſpecially while he was ſo happy, as to have good part of his Expences Defrayed by the liberal Contributions of that Eminent *Mecenas*, *Frederick* the II. King of *Denmark*, who thereby Recorded his Name in Immortal Characters on the Leaves of Fame) that would be neceſſary to the making all ſorts of Obſervations requiſite. As ſoon therefore as he had furniſhed himſelf with that *Aſtronomical* Colledge, or Tower for Obſervations, built by him in the *Iſland* of *Huenna*, to that purpoſe aſſigned him by the King, and furniſhed that *Heavinly* Cittadel by him called *Uraniburg*, with ſtore of Exquiſite and Magnificent Inſtruments Mathematical, he begun (having provided himſelf of ſundry Learned and Competent Coadjutors) exactly to Obſerve the *Altitude* of the *Pole*, in that Place, by the *Circum-Polary Stars*. By which underſtanding likewiſe the *Altitude* of

the *Equator*, he pointed out the *Equinoctial* Points, by the passing of the *Sun* through them: And attending besides to the middle parts of *Taurus* and *Leo*, he found out the *Apogeium* of the *Sun*, and the *Eccentricity* of it, and deduced its Course from the Point of the *Vernal Equinox*. Moreover, from *Venus*, in the Day time compared with the *Sun*, and in the Night with the *Fixt Stars*; he endeavoured to search out the *Right Ascentions*, & *Declinations* of the *Fixt Stars*: Which the Ancients had perform'd, but fallaciously by using the *Moon*, not *Venus*, to that purpose. And his Success was as Exquisite as his Care in this, that he Constituted that Bright *Star* which is in the Top of *Aries*, and ranged the chief of those in order along the *Zodiack*: And then advancing to enquire or rather find out the distances of the rest as well from them, as each from other, he defined both the *Right Ascentions* and *Declinations* of all; prescribed their several *Longitudes* and *Latitudes*, and added to the *Catalogue* of the Ancients about 200 other *Stars*, wholly by them omitted. Because the Ancients, Living in an *Horizon* much more *Southern*, had Observed and set down near upon 200 *Stars*, that are Invisible in the *Danish Horizon*, which is highly *Northern*: And *Tycho* again collected about 200 more than they could discern, and as being somewhat small, he intermixed them among others of greater Magnitude. Further, having in the mean space, always observed the passings of all the *Planets* through the *Merid.* and their several distances from the Chief *Fixt Sars* neareſt to them, he laid such solid Foundations, as by them might be exactly known, not only the true places of each, but also their several Motions. So that he came very near the height of his noble hopes of Building the whole Theory of *Astronomy* anew from the very ground, and of Erecting Compleat & Everlasting Tables for Calculation thereupon: But alas, prevented by an Immature Death, he could not accomplish his design. It was very much, however, that he went so far, as to have Recorded and bequeathed to Posterity such excellent Observations, by which *Kepler* was soon after enabled to Compose an intire Theory, and make the Tables called the *Rudolphine*; and by which, and others afterward contrivable, whatever can be desired in these Tables, may be fully supplied & perfected. And this among the rest deserves singular Commendations, that he left us the *Fixt Stars* re-installed in their true mansions; wherein he alone, in few Years Practice, performed and finished

niſhed that prodigiouſly great Work, which no man from the Days of *Hipparchus*, had either attempted, or in any meaſure Advanced.

I paſs by many other admirable diſcoveries of his, as that he was the firſt who demonſtrated all *Comets* to be carried freely through the Ethereal Spaces; that *Refractions* ought to be carefully conſidered and allowed for, and how; that he perceived that the *Latitude* of the *Moon* ought to be augmented by more than a *Quadrant* or fourth part, than had been conceived; that he almoſt demonſtratively convinced the *Latitudes* of the *Fixt Stars* to be varied; that he excogitated an *Hypotheſis*, which all thoſe who cannot allow of the *Ptolomaical*, for fear to allow the *Copernican*, may well adhere to and defend: With many other things, as difficult in their Invention, as Excellent in their uſe. And Obſerve only, how vaſtly he tranſcended all that went before him, in point of exactneſs and certainty. As for *Inſtruments Mathematical*, it is well known, he made ſuch, as for the Condition of their Matter, for the Vaſtneſs of their Magnitude, for their variety of Forms, for the Care of their Elaboration, for the Preciſeneſs of their Diviſions, and for the Facility in Uſing, as the *World* had never the like before. Again, ſo prodigious was his and his Coadjutors ſubtility, diligence, induſtry; that whereas the Obſervations of *Hipparchus*, *Ptolomy*, and all others before him had been marked out only by the ſixth, or at the moſt by the twelfth part of Degrees; he deſigned all his by the ſixtieth parts of Deg. called *Minutes*, or *Scruples*, and very often alſo by ſubdiviſions of *Minutes*. So that we may well demand what compariſon can be made betwixt that groſs way found out by *Eratoſthenes*, and approved and followed afterward by *Hipparchus* and *Ptolomy*, for the Obſervation of the *Obliquity* of the *Zodiack*, and that moſt fine and Exact one Invented by *Tycho*? His being, by a Diviſion of the *Merid.* into 83 parts, and the Interval of the *Tropicks* deprehended to take up 11 of them, it appeared that the diſtance of one *Tropick* from the *Equator*, amounted to 5 of thoſe parts and a half, or by a reduction of them again to Degrees of 23 Deg. 51 Min. and $\frac{1}{2}$ parts, and theirs, being by an hollowed *Hemiſphere* of Stone, with a *Gnomon* Erected in the middle, as we have formerly deſcribed it; and to wha Deg. of ſubtility and exactneſs this way of commenſuration could arrive, the meaneſt Novice in *Aſtronomy* may ſoon judge; That *Quadrant* likewiſe of *Ptolomy*, ſo much admired by Ancient

Ancient Authors; Pray how vastly short did it come of the perfection of the least that *Tycho* used? And the same may be said of his *Rules*; for, that those *Armillæ*, set up by *Ptolomy* in the entrance of *Alexandria* had any thing in them comparable to those Erected by *Tycho* in his *Uraniberg*, cannot in the least measure be argued from the other Instruments then in use. It is not necessary, we should here again review those Machinaments, or Engines, which the old *Egyptians* and *Babylonians* made use of, either in discerning the *Signs* of the *Zodiack*, or taking the Diameter of the *Sun*: Or those, which *Aristarchus* and *Archimedes* used, for commensurating the same Diameter. Only we cannot but wonder, by the by, how *Aristarchus*, having aimed so near the white of truth, in the matter of the Suns Diameter, and determining it to be the 720*th* part of the Circle, or half a Degree; as is delivered by *Archimedes* should yet err so widely in his Book of *Magnitudes* & *Distances*, as to make the Diameter of the *Moon* (which in truth is very near as great as that of the *Sun*) to be the 180*th* part of the Circle, or 2 Deg. when he called it *the Fifteenth Part of a Sign*; which mistake of his was long since taken notice of by *Pappus*. Nor is there any necessity, why we should survey those Instruments, that *Albategnius*, *Purbacchius*, *Reigiomontanus*, *Copernicus*, & other more modern *Astron.* used: considering, that besides the *Rules* made by *Regiomontanus* (which *Bernardus Waltherus*, his Disciple, preserved, and had recourse to, in his Observations of the Suns Altitude) they came so short of the least of *Tychoes*, in point of exact reasoning, & amplitude, that they deserve rather to be perpetually forgotten, than remembred to competition. However it is seriously to be wished, that the Observations made by those incomparable Instruments of His, may ly no longer concealed from the World (for by singular Providence they have been hitherto preserved, as *Gassendus* attesteth, *in the life of Tycho*) but soon be brought to Light. And this as well for sundry weighty Considerations there alledged by *Gass.* as for this, that not all the *Stars*, of which *Tycho* hath given a copious Catalogue in his *Progymnasmata*, may be found reduced to congruous Calculation (in as much as they do not exactly correspond with the Heavens) & that various Catalogues have been pretended from the same, which are very much different each from other: For all the difficulties hereupon depending may soon be removed, and all mistakes rectified, by having recourse to

the

the Fountain, or Original obſervations, which will clearly declare what hath been already corruptly deduced, and what may be at length carefully and demonſtratively deduced from them.

And, in the mean while, if *Hipparchus* his memory be ſo highly and (indeed) juſtly precious among learned men, for his great merits in excogitating and framing Inſtruments, whereby to take the dimenſions, diſtances, motions *&c.* of Heavenly bodies: certainly, that of our *Tycho* ought to be as highly eſteemed by us and all Poſterity; ſince he alone, for ſo many Ages together was found, that durſt not only imitate him in thoſe ſublime inventions; but ſo imitate, as very much to exceed him. For my part, truly; ſince *Hipparchus* may rightfully be called *Atlas the Second*: I ſhall do but juſtice to name *Tycho*, *Hercules the Second*, who relieving his Predeceſſors, long languiſhing and ready to faint under ſo prodigious a burden; which doubtleſs was the Reaſon, why *Kepler* called him, the *Modern Hipparchus*.

And thus have we in a ſhort Relation, rehearſed to you, what we could gather together, concerning the Original, Progreſs, and Advance of *Aſtronomy*, from the higheſt of times, of which there remain any Authentick memorials, down to the deceaſe of *Tycho Brahe*, the Noble and the Great. As for what *Additions* this excellent Science hath received, by the induſtry of *Aſtronomers* in this preſent Age, by the help of the *Teleſcope*, whoſe Invention may ſeem to have been unhappily deferred too long, as being deferred till ſome Years after *Tycho*'s death: they may be eaſily ſummed up. For all that our Days can juſtly challenge the honour of diſcovering, is (1.) the ſpots in the Sun: (2.) the inequality of the ſuperficies of the Moon: (3.) *Venus* ſhifting her appearances, as doth the Moon: (4.) *Mercury* and *Jupiter* in ſome Proportion, doing the like: (5.) *Jupiter* with a kind of a bound about him, and guarded with four leſſer Stars as Attendants: (6.) *Saturn* tripple-bodied: (7.) the *Gallaxy* fully beſet with ſmall Stars: and (8.) divers pale aſſemblies of ſmall Stars ſeeming to be only little white clouds in the *Welkin*, with ſome other particulars lately remarked. Now if you pleaſe to add this to the former ſummary; you have the whole (though brief) Story of *Aſtronomy*, from its very infancy to that augmented ſtate it now hath attained: I wiſh I might have ſaid to its *Full growth and Perfection*. But, alas! that is reſerved for Poſterity.

*FINIS.*

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